agriculture

Vol. 78 No. 8 August 1971

Published for the Ministry of Agriculture, Fisheries and Food
by Her Majesty's Stationery Office

7½p
MONTHLY

Anemones in Cornwall page 327

CROGGON WILL GO TO ANY LENGTHS TO MEET YOUR REQUIREMENTS.

Like this 400 ft. long, 75 ft. wide and 20 ft. high cattleshed we built for Ford & Etal Estates of Cornhill- on-Tweed. With our extensive range of standard spans, heights and lengths, we can construct steel framed farm buildings to suit every individual requirement, quickly and economically. And that's no bull.

Croggon
Established 1835

To: Croggon & Company Ltd., Poyle Steelworks, Slough, SL3 OAN.
Telephone: Colnbrook 4353, Extension 10.
Please send me further details of your steel framed farm buildings.
Name .....
Address .....

MINISTRY OF AGRICULTURE FISHERIES AND FOOD

Nitrogen and Soil Organic Matter

This bulletin is a record of the papers presented and of the discussion which followed at a conference organized by the Soil Scientists of the National Agricultural Advisory Service. It contains much information which will be of great value to research workers and advisers throughout the world who are concerned with nitrogen in the soil and for plant growth. (Technical Bulletin 15). (SBN 11 240915 6)

£2 (by post £2·10½)

Published by

HER MAJESTY'S STATIONERY OFFICE

and obtainable from the Government Bookshops in London (post orders to PO Box 569, SE1 9NH), Edinburgh, Cardiff, Belfast, Manchester, Birmingham and Bristol, or through booksellers

EVENSTORM IRRIGATION

★ Rotary sprinklers ★ Rain guns
★ Organic irrigation (effluent disposal)
★ Portable aluminium mains
★ Glasshouse and outdoor spray lines

EVENTHERM SPACE HEATERS—

★ Portable, oil-fired, up to 200,000 B.T.Us./Hour
★ Free-standing with Heat Exchanger up to 400,000 B.T.Us./Hour

Details from Dept. 'A', EVENPRODUCTS LTD., Evesham, Worcs. Tel. Evesham 41212.

Weldmesh

Regd. Trade Mark

IN ROLLS, SHEETS AND CUT-TO-SIZE PANELS

Direct from:
THE B.R.C. ENGINEERING COMPANY, STAFFORD *Telephone: STAFFORD 4441*

Agriculture

VOLUME 78 . NUMBER 8 . AUGUST 1971

Editorial Offices
Ministry of Agriculture, Fisheries and Food
Tolcarne Drive
Pinner
Middlesex HA5 2DT 01–868 7161

Contents

page

Anemone Breeding and Corm Production in Cornwall *Mrs. L. M. Gill* 327
Complete Diets for Ruminants *J. B. Owen* 331
Farm Ditches *J. Rowland Smith* 334
Husbandry and Horticulture Experimental Centres *R. Gardner* . 339
An Island Farm *John Perry* 344
Scrapie *Nigel Harvey* 349
Weather Forecasting for Agriculture *W. H. Hogg* . . . 352
Rother Valley Improvement Scheme *G. H. Partis* . . . 356
Barley for Layers *C. D. Rickaby, H. Higginson, D. Pollicott* and *J. B. Morrison* . . . 360
Farming Cameo Series 4: 49. North Riding of Yorkshire *Alec Calder* 364
Profit from Quiet Pigs *A. B. Trask* 366
In brief 368
Ministry Publications 370
Book Reviews 371
Agricultural Chemicals Approval Scheme 372

© *Crown copyright 1971*

Provided that the source is acknowledged in each instance such articles and notes as are published in this Journal without any specific reservation regarding copyright may be produced in any registered newspaper or public periodical without special permission. The Ministry does not accept responsibility for statements made, or views expressed, in signed contributions to this Journal or in those reproduced from another source.

Further, the Ministry does not accept responsibility for any of the private and trade advertisements included in this publication.

In the interests of factual reporting, occasional reference in this Journal to trade names and proprietary products may be inevitable. No endorsement of named products is intended, nor is any criticism implied of similar products which are not mentioned.

All communications respecting advertising in the Journal should be addressed to the Advertisement Contractors, Hannaford and Goodman (Associates) Ltd., 35 Sackville Street, London, W1X 1DB. Telephone: 01-734 0961.

Murganic RPB is now available in liquid as well as powder form

Murganic RPB seed dressing was first introduced in 1968 for the control of Loose Smut. It was in powder form and in both laboratory and field tests it has proved its effectiveness in keeping down Loose Smut and other diseases to which cereal seeds are susceptible. We now have Murganic RPB in liquid or powder form.

Murganic RPB contains Vitavax* a systemic fungicide and organo-mercury. It controls Loose Smut in winter and spring varieties of barley and wheat, Covered Smut and Barley Leaf Stripe. It also helps to reduce Glume Blotch and certain Foot Rots.

Murganic RPB Liquid: available in 5 gallon drums sufficient to treat 10 tons of barley or wheat.

Murganic RPB Powder: available in 5lb kegs sufficient to treat 1 ton of barley or wheat.

Murganic RPB in liquid form is as safe and as effective as the powder and is an easily applied and efficient seed dressing.

Murganic is a Trade Mark
*Vitavax is another product of Uniroyal

Jointly developed by Murphy Chemical Ltd. and Rothwell Plant Breeders.

Available only from:
Murphy Chemical Ltd. Wheathampstead, St. Albans, Herts.
Tel: Wheathampstead 2001 (STD 058-283)
Nickersons Seeds Wholesale, Holton-le-Clay, Grimsby, Lincolnshire. Tel: Waltham 3461. Telex 52261.

Commercial crop of anemones

EXPERIMENTAL HORTICULTURE STATIONS

Anemone Breeding and Corm Production in Cornwall

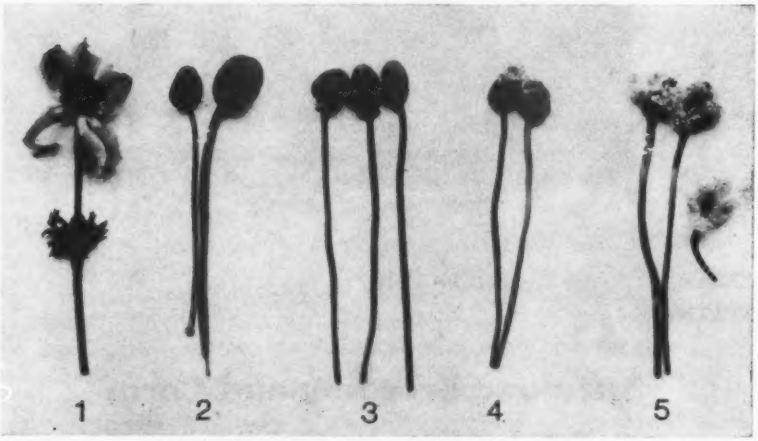
Mrs. L. M. Gill

ANEMONE coronaria was first marketed as a cut flower from the garden of Canon Boscowen at Ludgvan in 1924. Although the industry flourished until the early 1960s the area has steadily decreased and is now approximately 400 acres compared with 800 at the peak of production. This was due, in the main, to the summer selection of plants for seed in Holland which over the years has resulted in less hardy strains unsuitable for the winters in the South West.

Anemones still fulfil a useful function in the rotation in West Cornwall and on small holdings in Devon which other flower crops cannot replace. Employment is provided for regular workers in the off peak autumn months when grown from corms, or in the spring if grown from seed.

The climate of the South Western peninsula is such that, in the majority of winters when extremely low temperatures are not experienced, the hardiest of strains will grow and produce flowers from September to April. Since 1952 results of experiments at Rosewarne Experimental Horticulture Station and the sub-station at Ellbridge have provided up-to-date information for growers wishing to produce a satisfactory crop. They have been published regularly in the Station Annual Report.

At present, the most important aspect of work on anemones at Rosewarne is the improvement of strains and the commercial production of corms. This began in 1959 after an unusually hard winter when only a few plants survived. Since then selection and breeding by selfing, sibbing and crossing healthy, high yielding anemones has continued and the stage has now been reached when it is obvious that Rosewarne strains are hardier than the Dutch. More attention is now being given to improvement in the balance of colour, and at the same time an effort is being made to increase the yield per corm and the stem length and to produce flowers which have attractive buds and frills.



Development of anemone seed head: 1 Seed head develops, 2 Petals fall, 3 Seed head changes colour, 4 Seed head bursts, 5 Seed fluffs

Seed of Rosewarne strains was sown for corm production on a small commercial scale in 1968 and 1969 on relatively stone free, sandy soil at Hayle. During this period, a brush type machine was developed at Rosewarne to destone the soil in the seed beds and to lift corms at the end of the season. The mixture of soil and stones at de-stoning time was brushed from the front share over an $\frac{1}{8}$ inch sieve, the stones being deposited in the path by conveyor. At harvest time, the corms were fed into a side mounted box. That machine, however, had some limitations: a fairly clean sample of corms was obtained provided the soil was not wetter than good potting compost condition, and when beds were completely free of stones and weeds it worked without blockage; it could cope quite well with half an acre of land but above that there were always doubts whether the harvest would be completed before the onset of bad weather in the autumn.

A new machine has now been developed for the same operations which in preliminary trials on a $2\frac{1}{2}$ acre site shows some promise. It is an elevator type machine with a rear shaker to return the soil to the bed and convey stones to the pathways prior to sowing seed, or to convey corms into trays at harvest.

To sow the lint covered seed at 40 lb per acre it was usual to broadcast in sand at 5 ton per acre. Until the autumn of 1969 sowing was either by hand or drill, but as each year passed the acreage of seed bed increased and it

became obvious that a quicker method of sowing had to be found. In the spring of 1970, the seed was sown in water, using a 30 gallon sprayer with a fixed flood jet nozzle; the tank held only 25 gallons of water plus seed—sufficient to sow a 600 ft bed. The difficulty in wetting the seed was overcome by adding liquid soap to the water, and the seed had to be clean and free from pedicels to avoid blocking the nozzle. Difficulties were also experienced due to the seed settling in the tank. Harrowing was carried out as soon as possible after sowing before the seed dried and blew off the beds; some loss was incurred at this stage. These problems were overcome in August 1970 by using a 0·25 per cent alginate solution which kept the seed in suspension in the sprayer and also prevented rapid drying of the seed prior to harrowing.

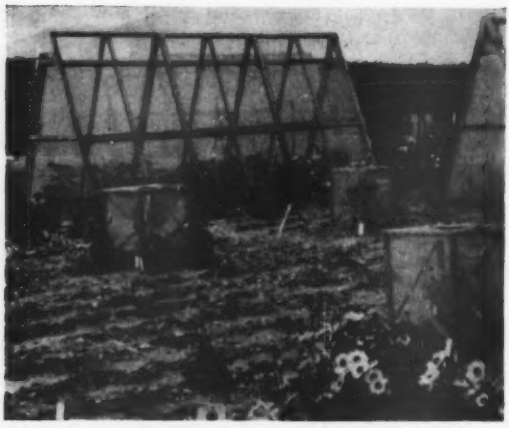
The beds were flat and Cambridge rolled after sowing and harrowing and the surface was then sprayed with a 50:50 bitumen soap solution at 400 gallons per acre to reduce erosion by wind. The use of this solution after a spring sowing absorbed heat in early summer and scorched the seedlings with serious consequences in dry weather. In August 1970 a 1:3 solution of latex and water at 120 gallons of latex per acre was applied on a small scale with apparent success.

Establishment of the seedlings was impaired due to sand blowing on to the beds from surrounding areas, where funnelling of wind occurred beneath nearby plastic mesh shelter. The erection of 4 ft lath fences has proved the most satisfactory means of shelter for small areas of corm production and it is hoped that there will not be any need to use shelter on larger areas where an overall spray of latex is used. The sprayer used for seed sowing also sprayed the beds with either latex or bitumen emulsion.

Anemone corm production

A pre-emergence spray with paraquat was supplied to kill early weed growth. Pre- and post-emergence herbicides have been tried at various rates of application. Terbacil at 0·3 lb at pre-emergence has given promising results and was also given a commercial trial in the spring of this year. Post-emergence and a combination of pre- and post-emergence sprays require further investigation.

Corms produced from an autumn sowing are usually harvested in June or July. The tops are encouraged to die back and dry by undercutting and are then burnt off with tractor-mounted flame guns. Tops of spring sown



Large and small cages for anemone breeding (see also cover photograph)

corms do not die back readily so it is difficult to flame gun effectively. Foliage desiccants have been tried but this method requires further study.

Whilst there has been an increase in the production of corms, there has also been a corresponding increase in the production of seed. In 1970, 2 cwt of seed was harvested from 6½ acres of land at Rosewarne where plants were rogued rigorously to improve the colour balance. Two of these acres were machine harvested and the remainder collected by hand. The fish tail of the machine designed at Rosewarne to undertake this work spanned three rows of plants. As it passed over the seed heads the downy seed was sucked by a fan into a double terylene bag; the inner layer, being coarse mesh, retained petals and trash but allowed free passage of seed into the outer bag. In 1971 this machine will be forward mounted and will span five rows.

Hand picked seed was removed just as the seed head began to fluff and was then dried in mesh based trays on framework shelves in a glasshouse. It was vacuum cleaned to remove all traces of material likely to block the nozzle of the sprayer, then stored under normal room conditions in pillow cases.

If anemone flower production is to return to its pre 1959 level of 800 acres, 40 acres of land would be required annually on a 7-year rotation to produce sufficient corms of Rosewarne strains to supply growers' needs. Eighty acres would be needed on a similar rotation for seed production.

The future of this project depends not only on the quality of the Rosewarne strains but on the full co-operation of growers who have the type of soil required for the success of the industry.

Mrs. L. M. Gill, N.D.H., is a Horticultural Adviser with A.D.A.S., stationed at Rosewarne Experimental Horticulture Station, Camborne, Cornwall.

★ ★ ★

Conventional systems of stock feeding can be wasteful. Cambridge University has been conducting trials to provide

Complete Diets for Ruminants

J. B. Owen

COMPLETE diets for feeding pigs and poultry are now universally accepted but not so long ago there were severe reservations about their use. It was questioned whether such unnatural feeding could support production and, particularly, reproduction without giving access to 'natural' foods like grass. Complete diets can be defined as an intimate mixture of processed ingredients presented in a form so as to preclude selection and designed to be the sole source of food. It is only fairly recently, with the development of barley beef systems, that *ad libitum* feeding of concentrates has been adopted for ruminants, and even in this case commercial practice has involved some supplementation with hay and straw.

Why complete diets?

What is the relevance of complete diets for ruminants today and what are the possible applications to cattle and sheep? They are relevant because labour costs are increasing rapidly and because there is an urgent need to remove the drudgery associated with many animal care operations. Then there is the introduction of the scientific and technical information upon which to formulate complete diets; and, most important, the way the problems of food processing have recently yielded to engineering advance.

Surprisingly, little information is available on their use for feeding to cattle and sheep, particularly so far as the dairy cow is concerned. However, a recent series of experiments at Cambridge University on dairy cows and sheep has outlined some of the factors involved (Owen, Miller and Bridge, 1969, 1971)*. First of all it is clear that there is no biological obstacle to their use that correct formulation cannot overcome. Grass—the model for good complete diets—seems to have no magical properties that set it apart from man-made mixtures.

Roughage levels

The Cambridge experiments first established the impracticability of allowing dairy cows simultaneous free access to long roughage and to concentrates in separate feeders. The cow tended to behave like a child might do if allowed to choose between sweets and bread, insufficient roughage was eaten to

*Owen, J. B., Miller, E. L. and Bridge, P. S. (1969). Complete diets given *ad libitum* to dairy cows—the effect of level of inclusion of milled straw. J. Agric. Sci., *72*. 351–357.

Owen, J. B., Miller, E. L. and Bridge, P. S. (1971). Complete diets given *ad libitum* to dairy cows—the effect of straw content and of cubing the diet. J. Agric. Sci. (in press).

maintain milk quality. Even worse was the tendency for the cows to eat the least roughage when they most needed it, in peak lactation. Subsequent experiments showed that *ad libitum* feeding of the dairy cow could be successfully carried out only if a proportion of roughage was mixed into the diet. The roughage was incorporated as chopped or coarsely ground barley straw and the diet given cubed or as a loose mix.

A critical interaction was demonstrated in these experiments between the level of straw and type of processing and their effect on dairy cow performance. Where the straw was chopped and the diet given as a loose mix, marked falls in butterfat levels and digestive upsets could be avoided with as little as 20 per cent of straw; with cubed diets, containing coarsely ground straw, the critical level was considerably higher.

It was also shown that lactation performance could be maintained over a range of included roughage levels without there being a marked compensatory increase in food intake. When cubed diets were used, performance was little affected and dry matter intake maintained even when straw formed 40–50 per cent of the diet. With loose mixes, intake and milk production fell when over 30–35 per cent of straw was included. Milk quality was normal when the optimum range of straw was taken but lower levels gave a marked depression of butterfat content with relatively high SNF levels. Conversely, on the high straw diets the cows showed all the signs of underfeeding—lowered yields, loss of condition and lowered milk SNF.

Other ingredients

The optimum level of straw to include depends on the make up of the basal diet, the relative cost of the straw and other ingredients and the cost of processing the diet. Of the other constituents of complete diets examined at Cambridge, barley was the main energy source although a proportion of sugar beet pulp has also been successfully used. The requisite overall crude protein content of about 10–11 per cent has been successfully achieved by using a variety of protein supplements such as oil cakes, beans, or grass plus a small level of urea. So far, a diet containing urea as the sole supplementary protein has given less satisfactory performance in comparison with beans or grass plus urea. A comprehensive range of vitamin, mineral and fat additives were included in the diets since the cow is now entirely dependent on its complete diet for such nutrients.

A similar type of diet containing 40 per cent of coarsely ground straw given as a loose mix has given excellent results when self fed to pregnant and lactating ewes. Complete diets containing 10–15 per cent of barley straw are also used for feeding artificially reared lambs, and conversion rates on such diets have ranged from about 2·5–3·0 on a dry matter basis in lambs from 10–40 kg liveweight.

These complete diets have numerous practical advantages. They cut out the complication of rationed feeding and its labour needs which, particularly in the case of the parlour milked dairy cows, is a severe limiting factor to simplifying animal operations. The animals can eat little and often, with no competition, in a fraction of the trough space required for conventionally fed animals and without the waste commonly associated with feeding long roughage—particularly with sheep. The reduction of stress in self-fed animals could in itself have a considerable effect on their well being.

Successful complete diet feeding ensures that the animal's consumption

precisely matches the planned composition of the diet and cannot vary in the proportion of roughage to concentrate as is often the case with group feeding. Dairy cows in early lactation and ewes in late pregnancy and early lactation have, at best, a limited capacity for food intake in relation to their high output; self feeding with a diet containing the optimum level of roughage ensures that each animal can eat to its capacity. With low quality dairy cows in later lactation it may pay to increase roughage content in the diet, although there is little reason why good cows should not perform efficiently on a single medium level of straw. Furthermore, a similar diet would probably also suit the dairy heifer calves being reared, thus further simplifying management.

As to the disadvantages, a primary danger of complete diet feeding when the change is made from conventional feeding is that of acidosis. This can be overcome by allowing plenty of trough space and by progressively increasing allowances in the changeover phase. Other technical snags would be the fault of the formulator and not of the system. Of course much more information will be needed to fill in the broad framework we have established in our work.

Costs

The economics of complete diet feeding are that, at present, processing costs for diets, including roughage, are rather high, but the advantages in labour and management can outweigh these on a properly designed unit. Since the raw materials are essentially the same as those used in conventional feeding, complete diet feeding could immediately replace traditional winter feeding for many housed cattle and sheep. Entry into the European Economic Community and the consequential higher grain prices it will bring should not affect systems based on complete diet feeding any more than traditional systems where the roughage and cereals are fed separately.

Long-term outlook

The feasibility of complete diet feeding has recently been given a boost through the rapid development of mobile food processing units capable of manufacturing diets containing straw, using the raw materials at the point of storage on the farm. The on-farm service provided includes the grinding of straw and grain and their mixing. A recent addition has been the incorporation of a high capacity cubing machine into the mobile unit.

In the longer term complete diet feeding is a natural complement to large cow units where size of operation precludes the practical adoption of conventional grazing during the summer months.

It may also be of use where really high stocking rates on grass are employed where the self feeding of a complete diet, deliberately designed to be less palatable than grass, could buffer high producing cows from the vagaries of seasonal fluctuations in grass growth.

A specialist function for complete diets is in the conduct of performance testing. Sire performance tests for beef and lamb can best be fully standardized and efficiency of feed conversion properly recorded where complete diet self feeding is adopted. Future genetic improvement in cattle and sheep is likely to come largely from such tests.

J. B. Owen, M.A., B.Sc., Ph.D., the author of this article, is with the Department of Agricultural Science and Applied Biology of Cambridge University.

Surplus water from farmland must be effectively drained. One vital link in the chain from farm to sea are

Farm Ditches

J. Rowland Smith

THE first task of the early settlers in Britain was to clear natural forest land to create an open area on which to graze their stock and grow their crops. Areas with good natural drainage were selected and temporarily fenced off for cropping and in this way problems of land drainage were very largely avoided. Over the centuries further areas of forest land were cleared to provide more and more open common land. At first, these open areas were farmed communally but population pressures and advances in agricultural techniques gradually demanded more intensive use of the land until eventually communal farming had to give way to individually occupied holdings formed by dividing up the common land. The holdings thus formed were enclosed, fenced and subdivided into separate fields. The process of enclosure went on for several hundreds of years, reaching its peak in the eighteenth century.

Once the open areas had to be divided into separate fields it became clear that land which was waterlogged or flooded would be of little value unless the surplus water could be drained away. In consequence a network of ditches were cut, usually starting from some point on the river system, with the job of:

Controlling and disposing of accummulations of surface water.

Preventing surface and sub-surface water moving from field to field.

Controlling and running-off the ground water of the area before it reached levels injurious to field crops.

Providing an outlet for the underdrainage systems installed within the fields.

The care with which these ditches were sited shows a thorough understanding of the nature of the terrain and must have resulted in a substantial reduction in waterlogging. Most of the present day ditches formed part of the network, many of which have been in use for some 150–200 years. The system of ditches is intensive in areas where the need for drainage is greatest and it is not unusual to find 15 miles of ditches for every thousand acres of land. Even today, when some ditches are being eliminated to create larger fields, it is unlikely that the length of channel will be reduced to less than 9 or 10 miles of ditches per thousand acres. The functions of ditches indicate the importance of the work they do and stress the reason why they remain an essential part of the land drainage system. They were designed to serve the area as a whole as well as individual fields and it is important to give full consideration to this fact before making any major alterations.

An upland ditch

Ditch design

To fulfil its purpose a ditch must be able to collect and convey surplus water to a point of outfall, and so its depth, capacity and siting are all of prime importance. The shape of a suitable channel also requires consideration. This is normally trapezoidal, having a wider top width than bed width, resulting in sloping banks which are more stable and in a channel that is hydraulically efficient. The following features of ditch design are the most important.

A good outfall

A ditch must be able to dispose of the water it collects. The water level of the outfall, watercourse or river governs the depth to which the ditches can be cut and a good outfall is one which not only receives the full discharge from the ditch but also allows it to be excavated and maintained at a level deep enough to do its job. In most areas, the discharge into the river system is achieved by gravity flow, but in some low-lying fens and marshes water can pass through sluices only at low tide or must be lifted by land drainage pumps into embanked rivers or the sea. The fens are a case in point where many thousands of acres lie below sea level and rely entirely upon pumping for drainage.

Depth

A ditch must be deep enough to provide an outfall for the lowest area draining to it and since field drainage systems are rarely laid at less than 30 inches below ground level there will be few cases where a ditch depth of less than 36 in. is required. Often it will need to be considerably deeper, particularly if the main purpose is to control the level of ground water in free draining soils; in these cases the area drained directly by a ditch and the underdrainage systems outfalling into it is closely related to its depth. The effective depth of the ditch is known as the freeboard, i.e., the difference between the surface of the water in the ditch and the lowest field surface level. In normal times there may be little depth of flow in the channel but

in wet weather the volume increases, thus reducing the freeboard. Ditches should be capable of meeting these storm flow conditions, particularly in cases of certain unstable soils or where high value crops are grown. Underdrainage systems can only tolerate complete submergence for short periods, and in the case of mole drainage inundation must never occur.

Capacity

The size of the channel should be sufficient to contain and carry spate flows without erosion, at the same time maintaining a sufficient freeboard. In fen and marsh areas, where the land is comparatively flat and the rainfall low, the runoff, often taken as the basis of ditch design, is of the order of 20 cusecs (cubic feet per second) per thousand acres or a half-inch rainfall in 24 hours; on the higher ground and in high rainfall areas of the midlands and western parts of the country flows of 40–80 cusecs may need to be catered for. In lowland areas, where some ditches depend upon sluices or pumps for an outfall, additional capacity must be provided to store water in between the operation of the sluices or pumps.

Bed gradients

The gradient to which a ditch can be excavated is to a large degree determined or influenced by the contours of the land. Since the line of the ditch is usually already fixed by field boundaries etc., the possibilities of greatly varying the gradient other than by changing the position of the ditch are limited. A very flat gradient in the bed frequently results in silting and weed growth and regular maintenance is called for. On the other hand, a steep gradient can give rise to erosion of the bed and subsequent collapse of the banks and steps may have to be taken to reduce the flow of the water by the construction of small weirs at suitable intervals. If this is not effective or possible it may be necessary to protect the bed against scour with a lining in the form of a concrete channel or stone pitching. In steeper ditches the speed of water flow together with the soil type affect the chances of bed and bank erosion; for example, soils of a coarse gravel texture will withstand velocities up to 3 ft per second, whereas in very fine sand erosion can occur if 0·5 ft per second is exceeded.

Bed width

The bed should be wide enough so that the ditch can accommodate peak flows without serious erosion to bed or banks but not so wide as to encourage silting and weed growth in periods of low flow. For practical purposes the use of modern ditching machines makes it difficult to obtain bed widths of less than 18 in. even though a smaller size may be desirable.

Slope of the banks

The slope or 'batter' of the bank must be sufficient to ensure stability or bank slips will occur. The suitable slope for a particular ditch depends on a number of factors, including soil type, and some indication can usually be obtained from an examination of existing or similar ditches nearby. Generally speaking ditches in sandy soils need to be cut to flatter slopes than those in clay; slopes in the order of 1 in 1 in clay, 1½ in 1 for loam and 2 in 1 or more for sand are normally suitable. In some situations even very flat batters will not give complete stability and it may be necessary to use a form of revetment to support the bank to avoid slips occurring.

Well maintained outfall ditches are essential for successful underdrainage

Ditch crossings

Bridges or culverts are required to provide access for farming purposes and each structure should be wide enough and strong enough to take all the machinery and implements likely to use it. They should in no way interfere with the free flow of the ditch water, otherwise a build-up will result in flooding upstream, erosion of the bed and possible undermining of the culvert downstream. For ditches draining small acreages, stoneware or concrete pipes can be used or where larger flows are likely a form of bridge may be preferable. Experience has shown that the use of small diameter pipes greatly increases the chance of blockage and nothing less than 9 in. diameter should be used.

Fencing

The bed and banks of a ditch can be seriously damaged where the ditch is open to fields carrying stock. To avoid this a guard fence should be provided, strong enough to keep the stock out but not too difficult to remove when the ditch is to be maintained.

Ditching operations

These days both new ditching work and the maintenance of existing channels is carried out by machine. The operations involve clearing overgrowth and cutting back hedges and trees obstructing the ditch, excavating the channel to the designed dimensions, spreading or disposing of the excavated soil, improving or constructing ditch crossings and erecting protective fences.

A wide range of field drainage operations including ditching work is grant aided under the Farm Capital Grant Scheme.

Maintenance of ditches

There are obligations on the owners and occupiers of the land to which the ditches belong to maintain them and to give uninterrupted flow at the correct level to their neighbours' ditches upstream. The work required consists of annually mowing the banks, removing plant growth and silt from the bed, throwing out any bank slips and water-borne debris and checking that all underdrainage outlets and culverts are clear.

The link between the farm and the sea

To sum up, ditches are the first line of defence against waterlogging and without them improvement of any poorly drained land by underdrainage works is impossible. If the channels are to do their job they must be correctly designed, properly constructed and well maintained. They must, in particular, have effective outlets to the rivers and the sea. Each link in this drainage chain depends upon the one downstream for effectiveness and it is, therefore, essential to keep the whole in good working order.

J. Rowland Smith, M.B.E., A.R.I.C.S., is a Senior Drainage and Water Supply Officer with A.D.A.S , at Ely.

Ministry Advisory Group for National Agricultural Centre

Following discussions between the Ministry and the Royal Agricultural Society of England, the Minister of Agriculture, Fisheries and Food has decided to base a group of specialists from the Agricultural Development and Advisory Service at the National Agricultural Centre at Stoneleigh in Warwickshire.

The group will comprise husbandry and other specialists covering the main areas of advisory work. They will form a national team under the direct control of A.D.A.S. headquarters. Further details are being worked out with the Society.

The National Agricultural Centre, created and financed by the Society, industries, organizations and others interested in the future of agriculture, provides a focal point for the demonstration and communication of new farming techniques and developments. The A.D.A.S. officers will be available on the spot at Stoneleigh throughout the year to provide technical help and advice for those responsible for its activities and for its large number of farming visitors.

Concentrating such a team of specialists at Stoneleigh will enable the agricultural industry to use more fully the Centre's facilities. At the same time it will leave the Society and others concerned with the activities at Stoneleigh to continue to play their own part and encourage them to do more. The responsibility for the National Agricultural Centre will, of course, remain with the Royal Agricultural Society of England.

The development of agriculture has been greatly helped by work at the Ministry

Husbandry and Horticulture Experimental Centres

R. Gardner, N.D.H., *A.D.A.S.*
Controller of Experiments, London.

THE establishment of the N.A.A.S. Experimental Husbandry Farms and Experimental Horticulture Stations was a direct consequence of the establishment of the National Agricultural Advisory Service on 1st October 1946. Most of the Centres were purchased in the late 'forties and early 'fifties and, on average, have been functioning for about fifteen years.

Prime functions

With the decision to merge the N.A.A.S. with other Ministry professional and technical services and to establish A.D.A.S. (Agricultural Development and Advisory Service) it is perhaps pertinent to examine the role of the Experimental Centres within the A.D.A.S. and to consider their likely functions within the new Service.

In attempting such an examination it may be helpful to define the relative roles of research and development about which there is often some confusion of thought. For a number of reasons it is important to understand the differences and relationships between research and development because each requires its own philosophy and attitude to its subject if human skills and material resources are to be used to the best advantage.

Research and development

The dictionary definition of a researcher is 'one who diligently examines'. In simple terms research is concerned with taking things apart, to ascertain what makes them tick and with what cause and effect. Successful development, on the other hand, must always be preceded by careful research and experimentation and is, in contrast to research, a process which entails 'piecing together' and 'building up'. The successful developer has a flair for readily perceiving how separate pieces of information, perhaps the result of research at widely separated points—even from other countries—can be pieced together to evolve improved and more economical systems or techniques of production.

As organized in Britain, publicly financed agricultural research is mainly the responsibility of the Agricultural Research Council at its own Research Institutes or at units based on university departments. The Ministry of Agriculture, Fisheries and Food, the Department of Agriculture and Fisheries for Scotland and some of the Universities also operate some research activities. Other Government financed bodies and agencies such as the Meat and Livestock Commission and the British Sugar Beet Corporation also make substantial contributions to the fund of knowledge.

Development, involving the integration of research findings and of original ideas from all sources into improved systems and techniques of production, is a main function of the Experimental Centres. This work may be undertaken either on a national or a local scale. Other public sector contributors in the development field are the Agricultural and Horticultural Colleges and some university farms. Also, there are the enterprising farmers and growers who develop and innovate in the hope of developing more efficient systems and of keeping ahead of their competitors.

Commercial research and development has a role complementary to the publicly financed work. The private sector can and does make a major contribution, especially where the end product is saleable and the profits are likely to recompense the research and development entailed. Much of the productivity improvement which has been a feature of the agricultural industry in recent years has depended on the discovery and development of improved forms of fertilizers, feedingstuffs, antibiotics, herbicides, pesticides, machinery, equipment, packaging materials, etc. But not all research and development work in such fields gives sufficient reward to cover the costs and still leave an adequate return on the capital invested, even though such developments may be of value to farmers and growers. This is particularly the case where the field of activity is the advancement of husbandry practice and production systems and techniques.

Integration of work and information

Some revolutionary extensions to the patent laws would be needed to enable developers of production systems to sell their 'developments' for cash. It is in this field that the A.D.A.S. Experimental Centres have increasingly operated in recent years, and here they can concentrate to most advantage in the years ahead. In this context the integration of the N.A.A.S. with the other technical services of the Ministry should be wholly beneficial, because experimental and development work on such aspects as farm buildings, veterinary science and drainage and water supplies can be brought squarely within the terms of reference of the Experimental Centres. This aspect has not, however, been entirely neglected in the past; at the Drayton, Boxworth and Terrington Experimental Husbandry Farms drainage experiments have been laid to the specification of the Ministry's Field Drainage Experimental Unit at Cambridge; and the Ministry's Veterinary Service has also been a valued collaborator in some of the livestock projects where disease is an important factor.

If the Experimental Centres are to achieve their full potential for the development of improved production systems and techniques as an aid to a continuing improved level of productivity in the agricultural and horticultural industries, one very important organizational requirement must be stressed. This is that A.D.A.S. and the staff of the Experimental Centres

must be free to draw on the findings of research, and of original thought and innovation from all parts of the world. If their activities were confined to the development of research findings generated by a single research establishment this would inhibit the integration of research findings from worldwide sources. The Centres must also be free to inject their own original ideas into the 'mixture'. This is especially important if the enthusiasm of the staffs of the Centres, and of their A.D.A.S. colleagues working in the frontline of advisory and development work, is to be fully harnessed in the furtherance of development work at the Experimental Centres. Some of the most dramatic and productive developments in the husbandry field achieved by the Experimental Centres have involved the integration of research findings from overseas as well as British sources, coupled with agronomic and technical knowledge in producing new production systems suited to conditions prevailing in Britain.

Fashioning policy

As the manpower and financial resources available to A.D.A.S. will, like the N.A.A.S., be limited it is essential that the resources available to the Experimental Centres should be concentrated on areas of experimentation and development likely to offer the greatest scope for improved productivity and directed to significantly large sectors of the industry. How can this be done?

It is essential that those responsible for planning and executing the work, mainly the Directors and technical staffs of the thirteen Farms, nine Horticulture Stations and two Horticultural Sub-stations shall be in close contact with:

a. Research workers in A.R.C. Institutes and other Government or quasi-Government research agencies, e.g., the National Institute of Agricultural Botany, the Meat and Livestock Commission, the Research Centre of the Food Processors and Manufacturers Research Association; and also with workers at research centres of industrial companies which operate in the agricultural/horticultural field, e.g., those producing fertilizers, feedingstuffs, herbicides, pesticides.

b. Colleagues in the field extension sector of the A.D.A.S. and also at other Farms and Stations.

c. Progressive farmers and growers, especially those with the flair and instinct for innovation and development of a sound and practical kind.

d. Overseas research and development workers, together with a screening of the literature from such sources.

All these requirements can, to some extent, be met by the individual initiative and action of the staff of the Experimental Centres. But some formal organization is also needed to undertake a reasonably continuous study of the scope for development in the production of the various commodities to decide to which facets priority should be given. Since the Experimental Centres were merged under one experiments directorate in 1969 the bodies responsible for these tasks have been streamlined and simplified. These are described overleaf.

Experiments and Development Committee

This is the senior body which acts as a Steering Committee to decide broad strategy for all forms of activity of the Experimental Centres in all sectors of agriculture and horticulture. It is particularly concerned with procuring and allocating the necessary resources of men and of money. Its membership includes senior representatives of the A.D.A.S. specialist departments, both in husbandry and in science, and of the Land Agency Arm and the appropriate administrative and finance divisions of the Ministry. A.D.A.S. membership also includes two Directors of Experimental Centres—one agriculturist and one horticulturist.

Because the Committee is concerned with overall strategy it does not include representatives from bodies or agencies outside the Ministry. Liaison with research and kindred organizations is achieved through a series of sub-committees responsible for the planning of the experimental and development programmes.

Work of Experiments and Development Sub-committees

The formulation of experimental programmes, relative to each commodity, is the task of Sub-committees of the parent E. and D. Committee. These cover the whole spectrum of agriculture and horticulture. The membership of each is small, usually not more than eight; this may include representatives from the appropriate A.R.C. Research Institute and from certain other bodies, senior A.D.A.S. officers of the Experimental Centres engaged in work on the specific commodities, science specialists and regional husbandry advisers. The A.D.A.S. farm management specialists also contribute through debate.

Each Sub-committee is charged with two main tasks. Firstly, to make periodic reviews of the economic status of the commodities for which it is responsible, including the effectiveness and profitability of current production techniques and the scope and need for improvement. Secondly, to arrange for the preparation of any necessary 'projects' arising from a commodity review. The object of a Commodity Review is to identify the points at which investigation and development work can most profitably be undertaken. If such studies reveal the need for more fundamental or basic research this is conveyed to the appropriate A.R.C. Research Institute, a representative of which may be serving as a member of the Sub-committee.

The normal outcome of a Commodity Review is either the recognition of a need for one or more projects to cover the needs disclosed by the Review, or the conclusion that no work is required or that its cost would not be justified by the benefits likely to be obtained.

Once the need for a project has been established an individual is invited to serve as a Project Consultant. He need not be a member of the Sub-committee but will have a specialist interest in the subject concerned. A project document defines areas of particular importance requiring experimentation and development and sets guidelines for the planning of individual experiments by the Directors and staff of Farms and Stations working on the experiment. The Project Consultant is the human link between the written objective, as set out in the project document, and the frontline experimenter or developer working on his crops/livestock at an Experimental Centre. Apart from the requirement that due regard be taken of the priorities laid down in

the project document, and that the Project Consultant be used in his capacity of consultant, Farm and Station staff are encouraged to exercise individual initiative in the conduct and further development of their work. Committees, however competent, cannot replace dedicated experiments as the key to success in development work.

Farm and Station Advisory Committees

Each Experimental Centre has an Advisory Committee which includes a number of local farmers or growers known for their progressive views and for their interest in farming technology or economics. The Farm or Station Advisory Committee is the major formal point of contact between the Centre and the farming community. It is therefore the duty of each Centre Director to encourage his Advisory Committee to:

a. identify those local farming problems which they consider to be of paramount importance so that the Director can take appropriate action, and

b. to comment on the suitability to local circumstances of projects emerging from the appropriate commodity experiments sub-committee. Normally the Directors of those Centres which have a major interest in the commodity(ies) covered by each sub-committee will also be members. They are therefore in a strong position to convey the views of the farming community in the area served by their Farm or Station to the appropriate sub-committees and thus help in the planning of sound national projects. In the reverse direction it is the duty of Centre Directors to represent to their Advisory Committees the views and strategies of each of the appropriate Experiments Sub-committees.

The need for emphasis on the development of more economic production systems for use on a national scale may seem to impinge upon the ability of Experimental Centres to study local problems. In this connection many problems which appear to be of local significance are also met with elsewhere and work upon them will be encompassed within the project devised by the Experiments Sub-committee. However, where this is not the case Centre Directors may mount investigations or pieces of development work as may be necessary to cater for the local need. In this connection the tackling of local problems should not be confused with the work which is frequently necessary for the satisfactory evaluation of new production systems and techniques under the special conditions of local climate, soil, etc. In this latter respect each Farm and Station has a vital local role, functioning as part of a national chain.

Finally, the Experimental Farms and Experimental Horticulture Stations were originally established to enable the N.A.A.S. to provide a firmly based Advisory Service. This they have done and, in addition, through the medium of their Open Days and visiting groups, have provided many thousands of farmer and grower visitors with a 'self-serving' supply of technical advice and information which customers can call and collect. These activities will continue to be a pre-requisite for the success of A.D.A.S.

The story of how an Isle of Wight farmer expanded his dairy enterprise by a second herd several miles from his main holding.

An Island Farm

John Perry

SINCE he first purchased Kingston Farm, East Cowes, ten years ago and commenced farming 180 acres alongside the River Medina, with an enviable view of Cowes Harbour and the Solent beyond, Richard Orlik has always been sufficiently confident about the future of dairying to adopt a continuous expansion policy.

Mr. Orlik took over a herd of sixty Friesian cows with the Farm, but as all the young stock and store cattle had been sold separately he had immediately to embark on a selective breeding programme to provide replacements and the additional heifers needed to implement his expansion plans. The herd is now 100 home-bred cows with an annual production level of 1,000 gallons of milk sales per cow.

Expansion

Due to economic and management factors, not the least being difficulties arising from the siting of the existing dairy premises in relation to the land, and problems raised by the continuing expansion of East Cowes on to land adjoining the farm, it became obvious that if more than 100 cows were to be kept, a second herd would have to be established elsewhere.

For a number of years Mr. Orlik rented part of Little Fairlee Farm, Newport, but it was not until late 1968, on the retirement of the owner, that he was able to purchase the whole of the farm and the opportunity arose to establish the second herd he had planned.

The new farm

Little Fairlee Farm is a 65-acre holding on the northern outskirts of Newport—the principal town of the Isle of Wight—about six miles from East Cowes lying alongside the now defunct Newport to Ryde railway line. It is moderately heavy clay land sloping gently westwards and really suitable only for livestock farming. The buildings were typical of a farm of this size, comprising a double-range cow shed capable of tying sixteen cows, a small barn and a number of loose boxes and store sheds of various forms of construction. A 75 × 35 ft steel-framed covered yard had been erected in the early 1960s to enable about forty cows to be batch-milked through the cow shed. Many of the buildings had later been converted to house pigs. Mains electricity was laid on to the buildings and mains water was available at the buildings and in most of the fields. The farm house was not sold with the farm.

The farm was clearly capable of carrying a dairy herd of between sixty and seventy cows but new milking facilities and cow housing were needed to cope with a dairy herd of this size. The fields were capable of sub-division into grazing paddocks with the minimum of reorganization and hedge removal.

Mr. Orlik, whose herd was one of the first on the Island to become accredited under the Brucellosis Eradication Scheme, decided to commence milk production at the farm last Autumn with thirty-six home-bred heifers. He plans to achieve sales of 1,000 gallons of milk per cow within three years. A further thirty-four heifers are being reared for introduction into the herd later this year.

Milking facilities

The immediate priority was the provision of up-to-date milking facilities and adequate housing for the first batch of heifers. In view of the distance of the unit from the main holding at East Cowes, it had to be completely self-contained and capable of being operated single-handed by the young herds-woman who had been recruited to manage the herd. Only limited capital, however, was available for investment in fixed equipment.

A prefabricated six-stall abreast milking bail, complete with milk pipeline and circulation cleaning facilities, was purchased at a gross cost of £1,130. It was chosen as being good value for money and well within the capability of the girl to operate alone. It also allows the cows to be given the bit of individual attention that Mr. Orlik considers necessary to achieve a high output.

Semi-circular collecting yard

The bail has been permanently fixed on a raised concrete base near the old cowshed. This has allowed part of the cowshed to be altered into a dairy. By taking advantage of a natural fall in the ground level it has been possible to construct a churn-loading stand outside the dairy at lorry height and at the

same level as the dairy floor. There is no bulk milk collection on the Island and it is unlikely to be introduced in the foreseeable future.

An augering system costing £192 has been installed to carry concentrates from a temporary outside container to the feed hoppers in the bail. In the near future this container will be replaced by a permanent galvanized metal self-emptying 10-ton bin.

The cows are held prior to milking in a 22 ft semi-circular collecting yard. A backing gate ensures the cows enter the bail with the minimum of delay. The fence to the yard is constructed of 2 in. diameter tubular posts set in concrete and five strands of high tensile wire. The gate and the posts for the fence to the yard were made by a local blacksmith for £65. The exit passage from the bail allows the cows to go direct to the fields in the summer months, or to return to the winter housing.

Augering system to carry concentrates to feed hoppers

Housing

The covered yard was at first the only available cow housing on the farm. After many years of having his Kingston Farm herd loose-housed on straw, Mr. Orlik switched to cubicles two years ago and he was not in favour of housing his new herd in a strawed yard. He fully supports the well publicized arguments that cubicles reduce stress, keep cows cleaner and save bedding costs. The choice was, therefore, between erecting cubicles in the covered yard or erecting new cubicle housing and using the yard for another purpose. The yard was incapable of being converted to hold all the cubicles needed so he decided to erect new cubicle buildings and use the yard as a covered feeding area and fodder store. He also decided the buildings would be constructed by his own labour—the new cubicle housing at Kingston Farm has all been constructed by Mr. Orlik and his staff.

The cubicle housing is being provided in two stages. A building with thirty-six cubicles was erected last autumn and a second building with thirty-four cubicles will be erected this summer to house the remainder of the herd. The

completed building, a 75 × 22 ft monopitch building adjoining the existing yard, was constructed of timber clad with 24-gauge prepainted galvanized sheeting. The cubicles are 7 ft long by 4 ft wide with divisions of two 4 × 2 in. horizontal timber rails, the bottoms of which are set 13 in. and 32 in. above the cubicle bed. A head rail is set 24 in. from the front of the cubicles. The beds are of rammed chalk topped with straw. The building was erected in about three weeks by Mr. Orlik and his tractor driver with the help of a local boat builder, and is estimated to have cost about £600 before grant. The timber cost £140, the prepainted galvanized sheeting £200 and labour about £100. The remainder of the £600 was spent on building materials. All thirty-six heifers took to their cubicles without any trouble and used them continuously throughout the winter. The second building will be of a similar design.

A 12 ft wide strip of concrete with a floor-level manger along one side has been laid in the covered yard to provide a feeding area. This summer it will be widened and a second manger added to provide adequate feeding areas for the whole herd. The remaining area of the building will be used for the storage of hay and straw.

Slurry disposal

Slurry is scraped daily from the cubicle building, feeding area and collecting yard into a 25 yd square storage compound excavated on a site near to the end of the feeding area and cubicle shed. The excavated material has been used to form earth banks giving an effective depth to the compound of 3 ft at one end and, by again taking advantage of a natural slope in the ground, 5 ft at the other. The compound was excavated for £47 and held all the slurry produced last winter. It will be emptied by a contractor during the dry period in the summer months, when it will also be enlarged to hold all the slurry produced in future years by the full seventy-cow herd.

Excavated slurry storage compound

Costs

The building costs are made up as follows:

	£		£
Milking bail, including equipment	1,130		
Augering system and bulk bin	550		
Bail base, dairy, churnstand and collecting yard	1,940		
	3,620		
Less 40 per cent grant	1,448	=	2,172
Cubicle shed	600		
Feeding area and slurry storage compound	150		
	750		
Less 30 per cent grant	225	=	525
Estimated cost of second cubicle shed	650		
Estimated cost of enlarging feeding area and slurry storage compound	150		
	800		
Less 40 per cent grant (assumed)	320	=	480
Estimated total cost	5,170		
Estimated cost after grant			3,177

For seventy cows this total cost represents a net expenditure of about £46 per cow. The cubicles cost about £12 each, after grant.

The author, **J. F. G. Perry, A.R.I.C.S.**, is a Senior Surveyor with A.D.A.S. at Winchester.

BULB DIPPING WITH ORGANOMERCURY COMPOUNDS

A Warning to Bulb Growers

Bulb growers are warned of the risks of using organomercury bulb dips.

Organomercury preparations are perfectly odourless in use and one of their main dangers is that the effects of poisoning are not immediately apparent. Persons exposed to vapour from the dips or whose skin is contaminated by the liquid may suffer from damage to the nervous system and the kidneys. Apart from the suffering involved, the poisoning is often irreversible and can result in permanent incapacity for work.

Because of these dangers, organomercury bulb dips should only be used in premises registered under the Factories Act, where regular expert inspection can ensure that the right precautions are taken against a build-up of concentrations of mercury in the atmosphere, that the processes used are safe, and that proper protective clothing is worn.

Advice on other, less hazardous methods of bulb dipping may be obtained from the Agricultural Development and Advisory Service.

In this article the author summarizes available information on the problem of the sheep disease

Scrapie

Nigel Harvey

IN purely economic terms, scrapie is not among the major afflictions of British livestock. It is not officially classed among the principal animal diseases and the losses it causes are appreciable rather than dramatic. But neither the sheep farmer nor the scientist can take much comfort from such Olympian considerations. To both of them a killing disease of unknown origin and unpredictable spread for which there is neither vaccine nor cure presents a substantial and continuing problem.

Familiar disease

The disease is not a new one and its common name, as well as much lesser-known local names as 'rubbers', 'shakings' and 'goggles', record the familiarity of generations of farmers with the intense itchiness, nervous disturbance, staring gaze and abnormal gait which are its unmistakable symptoms.

The disease has been known in this country for more than two hundred years. In 1755, for example, it was sufficiently serious in the Boston area of Lincolnshire for local farmers to petition Parliament for powers to prevent traders mixing healthy and diseased sheep; a generation later the reports of the Board of Agriculture showed that the disease was common in many southern counties. Its incidence then apparently declined but revived again in the Border district at the end of the nineteenth century. Its characteristics, however, were unchanged. The farmers of Roxburghshire and Northumberland could do no more than repeat the succinct comment of an observer who had witnessed an outbreak in Lincolnshire a lifetime previously. 'The sheep rub themselves to death', he wrote, adding that there was 'No cure.'

Research defines problems

There were, of course, numerous opinions about its origin. Some thought it was hereditary, some noted its association with particular breeds, some ascribed it to such picturesque but improbable causes as thunderstorms or sexual excess. The reasons for such beliefs did not survive the increasing interest of research-workers in the disease which followed the first neurological investigations of diseased sheep in 1898. But the scientists are still unable to replace them with evidence that explains the disease. For scrapie has proved one of the most intractable, nagging and tantalizing of all problems in the realm of biological research.

The research effort devoted to this disease in the last three-quarters of a century is considerable. So is the number of reports it has produced. And the story they tell of successful and unsuccessful detective work, of measurements

and hypotheses, of facts and deductions, of observations and possibilities, of argument and counter-argument, is absorbing. It is also inconclusive. We know that the disease can be transmitted experimentally by inoculation with certain tissues from an infected animal, though we do not know how it spreads under agricultural conditions. We also know that it has an abnormally long incubation period, sometimes as much as four years. But its origins are still a mystery and its cure unknown.

Nevertheless, the scientists have now defined the problem. They cannot tell us what causes scrapie but they can tell us a good deal about the obscure and elusive agent responsible.

Mystery of the causative agent

Thus, they have established that this causative agent can increase in quantity as it passes from animal to animal. This implies that it can reproduce itself, which in turn implies that it is alive and suggests that it is some form of virus. But it does not pass some of the traditional tests which determine a virus. It grows very slowly in tissue culture in phase with the cells of the culture, in an entirely different manner from a virus; no antibodies have been found in affected animals and it cannot be identified by the electron microscope. Furthermore, it can survive heat and chemical treatments which inactivate all known types of virus.

More fundamentally and more mysteriously, it contradicts itself. It shows the basic property of life, the power to reproduce itself, yet it contains no nucleic acid, which is now accepted as an essential constituent of living matter. No satisfactory theory has so far been devised which can account for this combination of properties. Indeed, its existence has been described as 'a bomb in the basement of the structure of molecular biology', which rests on the principle that every self-replicating organism contains nucleic acid. But it is not likely that the principle will be overthrown. It is more probable that the secret of scrapie will eventually prove to be reconcilable with established theory.

Possibilities and investigations

Various hypotheses are now under investigation. Perhaps the causative agent will be found in some substance which causes the genes of the infected animal to produce more of itself, perhaps in some substance in the tissues of the healthy animal which combines with some agent from the infected animal to form an infectious complex. Perhaps it arises from some change in the structural pattern of a membrane. As yet, however, such possibilities remain no more than theories without experimental evidence to prove or disprove them. Research continues, each experiment adding to the sum of knowledge and understanding, and one day we shall surely know the answer. Time, techniques and the tireless curiousity of the human mind are a formidable combination in this quest.

At present we do not know the answer. We can only await the findings of the scientists and we cannot expect any early conclusion to their work. It should, however, comfort us while we wait to know that these findings may help people as well as sheep. For it seems possible that they will also throw light on the grievous and mysterious problem of multiple sclerosis.

Here and now

Meanwhile, back at the farm . . . What can the farmer do to protect his flock? Nothing at all. What can he do if he finds the disease among his sheep? He can call his veterinary surgeon to make sure that it is scrapie and not some other nervous disease, such as louping-ill or sturdy. But if scrapie is diagnosed, he can only remove the infected animals, their parents and their progeny, for slaughter. It is painfully significant that outbreaks in Australia, New Zealand and North America, all of which were traced to imported animals, have been controlled by slaughter.

There is, however, one thing the farmer should not do. He should not conceal the occurrence of scrapie in his flock. It is clear that this has happened in the past and some of the regional and breed differences in the incidence and spread of scrapie probably reflect the consequences of such irresponsibility. For a farmer with scrapie in his flock is maintaining a reservoir of the disease which can be transmitted to other flocks with any sheep he sells. Here as elsewhere, honesty is the best policy. Indeed, if there is to be any control of scrapie here and now, this is the only policy.

Nigel Harvey, M.A., A.R.I.C.S., the author of this article, spent twelve years in the Ministry and twelve with the Agricultural Research Council. He is now with the Department of the Environment.

Fertilizer Practice in England and Wales

In the footnote to the article *Fertilizer Practice in England and Wales* published in *Agriculture*, July 1971, reference was made to the statistical data which was obtainable on request from the Ministry*. The following data is currently available:

SS/FLC/87 Farming type regions for fertilizer survey estimates. *Definition of regions.*

SS/FLC/88 Fertilizer practice in England and Wales, 1969. *Main tabulations.*

SS/FLC/93 Fertilizer practice in England and Wales: a new series of surveys. *Aims and methods for the series of surveys begun in 1969. Average practice in 1969 compared with recommendations.*

SS/FLC/94 Types of fertilizers used on farm crops in England and Wales, 1969.

SS/FLC/96 Some factors influencing fertilizer consumption on farms in England and Wales and the use of fertilizers on cereals and grassland. *Farm size and type, rotation type, previous cropping, years in continuous cereals, soil type.*

SS/FLC/97 Fertilizer practice in England and Wales, 1970. *Main tabulations.*

SS/FLC/100 Types of fertilizers used on farm crops in England and Wales, 1970.

SS/FLC/101 Average fertilizer practice in farm type regions of England and Wales, 1969 and 1970. *Basic tabulations for individual farm type regions, broad farm type groupings and N.A.A.S. regions.*

*Ministry of Agriculture, Fisheries and Food, Regional Administration Branch, Room 214, Great Westminster House, Horseferry Road, London, S.W.1.

Weather Forecasting for Agriculture

W. H. Hogg

THE fourteenth Aberystwyth Symposium in Agricultural Meteorology was held at the Welsh Plant Breeding Station on 17th and 18th March 1971. The topic for discussion was weather forecasting for agriculture and industry, the inclusion of industry being a departure from the purely agricultural topics of all previous symposia. Happily, the meeting was extended to allow for this and a very wide field was covered concerning agriculture and weather forecasting, from the organization of meteorological advice to its present and possible future use by farmers and growers. This article mentions some of the points made by the speakers, who were drawn mainly from agriculture, meteorology, the Universities and Research Stations.

In the opening discussion on the organization of meteorological advice it was emphasized that meteorology must take account of business objectives, and should be developed as a management aid. It is no longer sufficient to measure the success of weather forecasting by the position of lines on maps; instead it must be judged by the economic results of decisions taken under conditions of risk and uncertainty. For farming, weather forecasts must look backward and forward; backward because field operations depend on past as well as on current weather, and forward because farmers would find the task of planning much easier with a knowledge of the weather to come over several days. One possible development could be based on the forecasts given in the Sunday television farming programme, which are of great interest and value to many farmers.

Value of forecasts

It is, of course, essential that meteorologists should know what farmers require of forecasts and how they use them so that their own efforts may be most effectively directed. With this in mind an exercise in meteorological market research was recently undertaken in the South West and West Midland Regions and in Wales. Over 90 per cent of the farmers questioned used daily weather forecasts regularly or often, mostly those broadcast on radio or television; many supplement the general forecast by their own local knowledge and by telephoning the local forecast office in relation to specific farm operations. Forecasts are used mainly in the summer half-year for a variety of farming activities which include spraying, conservation and the harvesting of a wide range of crops, e.g., strawberries, hops, cereals and herbage seed. In winter there is usually rather more time for most farm jobs so that the effect of inclement weather may be felt less. There are, however, many exceptions to this when forecasts are invaluable; lambing is an obvious example, and the harvesting of such crops as leeks and Brussels sprouts.

To farmers, the most important elements in a forecast are sunshine and rainfall, mainly because of the effects on silage-making, haymaking and the cereal harvest. Their main interest for these operations is the drying power of the air; ideally, they would like some kind of drying index to be included in forecasts. Failing this, they would be very much helped by local forecasts of rainfall, which several farmers suggested should be broadcast by local radio stations.

Longer-term forecasts

Farmers were also questioned about the possible value to them of weekly and monthly forecasts; their replies emphasized the importance for planning, although a few farmers stressed that shorter-term forecasts of up to about a week were more important to them. The importance of monthly forecasts in relation to grassland management is evident. In autumn, a more open season will allow stock to be kept out longer; in spring, information on rainfall could lead to the saving of two weeks' winter feed by the application of fertilizer and controlled grazing. The arable farmer is probably most interested in the timing of cultivation and drilling. He wants to know when he can get on to the land, and a general monthly forecast should be sufficiently accurate for this; it should allow him to make his own estimates of soil moisture status and soil temperature a few weeks ahead.

In the hope that long-range forecasts will become reliable, now is the time to consider their agronomic implications and one paper dealt with the possibilities which would emerge with forecasts for 5 days, 5 weeks, 5 months and 5 years. There are a number of causes of variation in the yield of crops, those due to the soil and microclimate, to the managerial capacity of the farmer and to the weather. Weather conditions are responsible for fluctuations in yields from year to year on similar fields and under the same standard of management.

Management and the weather

One way to overcome some of the variation caused by the weather is to adjust management more skilfully. With very long-range forecasts (5 years) it should be possible to reach decisions on the general pattern of investment.

National policy with regard to support of developments in marginal areas would also be affected and the choice of crops to be grown could be influenced, e.g., farmers might switch from cereals to grass or vice versa in response to forecast trends in the climate.

At the other extreme, 5-day forecasts may be highly important in short-term planning, but 5-week forecasts may prove to be somewhat limited in value. Five-month forecasts could yield great benefits but they would need to be issued in good time, before crops were sown. For the maximum use to be made of such forecasts we must equip ourselves with a great deal more information on the relationship between crop yields and seasonal weather. Can we, for example, choose varieties which are most likely to thrive in the expected weather, so that we get the maximum output over a series of years? It is clear that much work needs to be done before these forecasts can be developed and used to advantage, but even if they could be issued now there are some ways in which they could be of benefit. For example, a decision could be taken on whether marginal crops, such as outdoor tomatoes, should be grown. They could also help in the management of scarce water resources, in the planning of timely measures against diseases and pests likely to be favoured by the expected weather, in determining the acreage needed to achieve a given tonnage of a crop and in a number of other ways. It is clear that much work is necessary on the agronomic implications of these forecasts.

There are major difficulties to be overcome by meteorologists before we can expect long-range forecasts which could confidently be used as a basis for major management decisions. The standard methods of extrapolation largely used in daily weather forecasting are no use beyond 5 days and about 15 days is the maximum possible in the future. Long-range forecasts are concerned not only with the development and movement of weather systems which already exist, but also with the birth and decay of systems which have yet to appear. Included in the many factors which may have to be considered are the relationship between the physical condition of the earth's surface and the large-scale characteristics of the earth's circulation; the effects of sea temperature, sea ice and snow cover, of solar disturbances, volcanic dust and other pollution veils, and the identification of possible rhythmic or cyclic tendencies in the weather.

The range of possibilities over the last 100 years indicates how important is the problem of long-range forecasting. In the lowlands of central England the temperatures in summer—June, July and August—have ranged between those normal for northern France and for Inverness-shire, while the warmest winters—December, January and February—resemble those for southern Ireland and the coolest for southern Sweden. It is worth emphasizing that these comparisons relate to whole seasons and not merely to isolated days or months within the seasons.

A paper dealing with meteorological forecasting and agricultural management was concerned with the use of weather or climatic data to make predictions which would help in reaching decisions on investment or on the long-term use of resources. We can identify three classes of decision:

(*a*) Actions based on early warnings, mainly the forecasting of biological consequences of certain weather. These include warnings of plant and animal diseases. For plant diseases, especially potato blight, the warning is short and mainly tactical, but for certain animal diseases the warning

period may be measured in months.

(*b*) Land use and enterprise selection. This is mainly medium- or long-term action, two years or more. These are likely to be of more value in the developing countries and an example was quoted from Uganda where the probability of enough early rain justified bringing forward the traditional planting and hence the harvesting of maize; this left enough time to plant and grow a cash crop like cotton in the 'second' rains and harvest it in the dry season. It may well be that such selection could be useful in developed areas, e.g., entry into E.E.C. could lead to greater cereal acreage in the wetter parts of Britain and feasibility studies undertaken now could provide the basis for future action.

(*c*) Investment in 'weather-proofing' and environmental improvements, mainly in water control, field equipment, machinery and farm buildings. When considering water control it is essential to take into account extra consequential costs for fertilizers, cow housing and larger parlours which may exceed the cost of installing irrigation. Continuity of farm income is an important factor and investment in field equipment and machinery should, therefore, give due regard to those years with unusual weather. Much capital is tied up in farm buildings, mainly those protecting livestock against the weather, and there is now a strong case for farm buildings experts, animal physiologists and meteorologists to determine the extent to which this investment is really necessary.

Two of the contributions placed emphasis on grass and potatoes. The first of these described work which showed how spring growth and date of heading of perennial grasses could be estimated from spring soil and air temperatures, so that by the end of March it should be possible to estimate whether the heading of early varieties is likely to be early or late. An important practical consequence of this would be the foreknowledge of low yields of digestible dry matter, for example, when a late spring is followed by a warm or average late April and May.

A twelve year prediction

A Pembrokeshire farmer gave a fascinating talk about his study of weather records in relation to the production of early potatoes. The best weather for this is a mild, unsettled winter to encourage steady growth during the chitting stage and to keep soil temperatures high. From the end of January until early March dry weather with a reasonably high soil temperature helps timely planting. A moist, warm March and April induces early haulm growth and a fairly dry and sunny May improves the quality and accelerates the maturity of the crop; if this is followed by a cool and showery June the spread of potato blight should be checked and there will be every hope of a good crop. Past weather records have enabled the farmer to identify alternating 5 and 6 year periods, which are respectively favourable and unfavourable, for early potato production. He anticipates a change to harder drier winters before long, unfavourable to early potatoes, followed by more favourable weather in the period 1977–82. It will be most interesting to look back in about 12 years' time to see whether such predictions—far beyond the daring of any professional meteorologist in this country—are borne out by financial returns.

W. H. Hogg, M.Sc., a Principal Scientific Officer of the Meteorological Office, is an adviser to the Ministry of Agriculture, Fisheries and Food at Bristol.

A synopsis of the 10-year development proposals of the Kent River Authority's

Rother Valley Improvement Scheme

G. H. Partis

THE River Rother rises at Rotherfield in Sussex and flows eastwards to the edge of Walland Marsh, the western part of the area known the world over as Romney Marsh. Here, the river turns south, passing the picturesque town of Rye and then to Rye harbour and the sea.

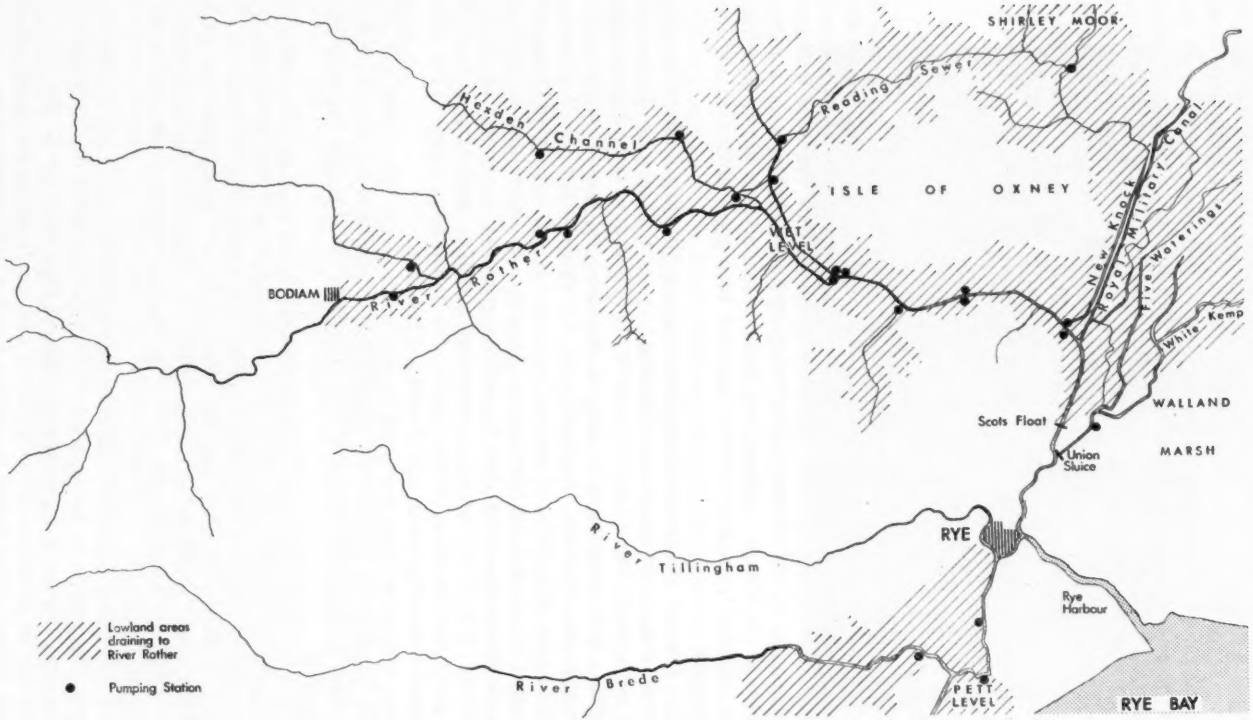
The reclamation of the marshes by 'inning'*, the diversion in the Middle Ages of the river from its former course (the present Reading Sewer) and the construction of the Royal Military Canal in Napoleonic times are some of the factors which have influenced the evolution of the somewhat complex drainage system which exists in the Rother Valley today. The map illustrates in broad outline the present situation.

Problems

As far as Scots Float the river is tidal and embankments are required to protect against tidal inundation. Above Scots Float the channels are embanked to allow flow from the upland to be passed through the marshes—the flat, alluvial flood plain mainly in grass and in places literally marsh. These marshes, excluding the 3,200 acres of Shirley Moor, total about 7,500 acres and all, given good drainage, are potentially highly fertile; so much so that seventeen private pumping stations have been constructed to serve individual farms or blocks of land. Lying alongside the lower part of the river is Walland Marsh, of which 8,000 acres drains to the Rother through Union Sluice. Still further downstream is the Rock Channel which brings in the combined flow of the Rivers Tillingham and Brede (2,812 acres of lowland).

The marshes which are below high tide level, some as much as 10 feet, extend for 17 miles from the river mouth and rely on gravity drainage into the river whose flow is interrupted when the rising tide closes the tidal doors at Scots Float. This 'tide locked' period may be as long as four hours, and combined with high upland flow results in flooding of the lowest land (the Wet Levels) as frequently as four times a year and of some of the marshes annually. When the river is high and the drains and ditches cannot discharge freely, practically the whole of the low land can be affected. This occurs roughly every other year but some smaller areas are affected more frequently. Where pumps have been installed by individual farmers the land has been described as 'tremendously productive' . . . 'an oasis of ploughed ground',

*The gradual process of winning land from the sea by enclosing with embankments.



Map showing present drainage system in the Rother Valley

and one considers his pumping system has made 'all the difference between arable farming and a duck shoot'.

A particularly bad flood in the summer of 1958 caused severe losses and in Shirley Moor 300 acres of arable crops were lost, 100 acres of hay and clover seed were not harvested and about 400 acres of grass was killed off with the result that ploughing up and re-seeding was necessary. To give some protection against the recurrence of such an event and to improve the drainage generally, the Kent River Authority and the Internal Drainage Board carried out the Shirley Moor Improvement Scheme. The works, however, were known to be only a first stage, since these improvements to Shirley Moor meant that under certain conditions there would be a harmful effect in some other areas. It was recognized that sooner or later the River Rother itself would have to be tackled.

Solution

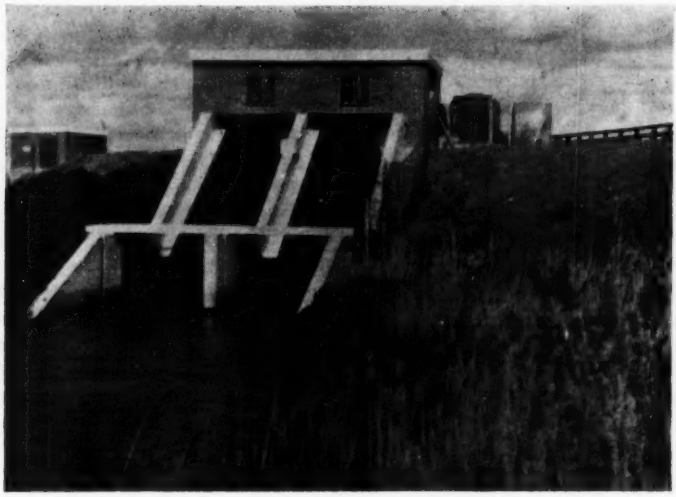
Various possibilities of improving the Rother were examined, evaluated and finally a decision was made to increase the size of the channel and to raise the level of the Rother flood embankments so that greater flows could be passed without over-topping the banks and flooding the marshes. The work would be accompanied by the construction of pumping stations to drain the marshes and the whole scheme so phased and operated that no area was made worse, even temporarily, because another area had been given protection and improvement.

This solution was further complicated because the magnitude of flood to be dealt with could not be accommodated by practical increases in channel size and embankment height. In times of high flood some temporary storage continues to be essential in an area of very low-lying ground which always performed this function—the Wet Levels. The three parts of the Wet Levels have an area of 1,200 acres and are between 1 ft and 4 ft above Ordnance datum. They are flooded often and for long periods—more than 6 weeks in October/November 1960—but by utilizing pumping equipment to empty them after a flood has passed it is expected that after the Scheme is finished the duration of flooding will be considerably decreased; a repeat of the 1960 conditions would produce only 2 weeks of flooding.

One further problem remained in that parts of the Pett Level and the Brede Valley could be adversely affected and so provision has been made for pumping to counteract this and also to provide for a general drainage improvement.

The Kent River Authority's scheme on which work was begun in 1966 and is planned for completion in 10 years, is estimated to cost £700,000. It includes the raising of tidal and river banks and the improvement of channels over a length of nearly 30 miles and the construction of twenty-three pumping stations. Many outfall sluices need to be re-built or extended and complementary works are to be carried out by the Internal Drainage Boards whose areas are affected.

An interesting feature of the pumping stations is that, apart from the largest, the pumps so far installed or ordered are all of the Archimedian screw type. Besides being marginally cheaper than other forms, this type of pump has the advantage of being able to pass weeds and so the usual task of screen raking, which would be quite a problem with twenty-three stations working at once, can be reduced.



Archimedian pump at Blackwall Pumping Station

Each pumping station has to deal not only with the marsh in which it is situated but with a varying amount of higher land draining into the marsh. Segregation of high-land water was found to be generally more expensive than accepting and pumping it.

The whole of the works have been designed by the Kent River Authority's staff and carried out by direct labour. A degree of standardization has been adopted and several unusual features incorporated; for instance, no lifting gear is provided inside the pumping stations as the roofs can be readily removed to allow a mobile crane to be used when an electric motor or gear box needs to be taken out for repair or alteration.

Results

The benefit from all these drainage works extends beyond the mere prevention of flooding to the provision of better conditions for growing crops which will result in higher yields and a much greater flexibility of crop rotations. The early work in Shirley Moor, and the installation of small pumps by individual farmers, set the pace and so far over 2,000 acres of under-drainage with its associated ditching has been completed and upwards of 1,500 acres have been ploughed from grass and have produced good yields. Not only has the lower land benefited but greater flexibility has also been imparted to the upland which is usually farmed with it. As the whole Scheme nears completion, impetus has been given to the carrying-out of the 'follow-up' work of ditching and under-drainage which is needed to provide the best conditions for growing both grass and arable crops.

The author, **G. H. Partis, C. Eng., M.I.C.E., A.R.I.C.S., M.I.W.E.,** is a Regional Engineer with A.D.A.S. at Tunbridge Wells.

Barley for Layers

C. D. Rickaby
G. Higginson

D. Pollicott
J. B. Morrison

ALTHOUGH research work has shown that barley is a perfectly safe cereal to feed in quantity to laying birds, poultrymen and advisers alike have been reluctant to include it in liberal amounts in the diet for light-medium type hybrids. Furthermore, although barley has always been considerably cheaper than maize—by some £3–£5 per ton—the fear has been expressed that the replacement of maize by barley would adversely affect both egg production and egg weight, and that profitability would be reduced.

The two diets

This article gives a brief account of a trial carried out on a commercial scale on two farms during 1968–69 to compare the performance of light-medium hybrids on two balanced diets—a control ration called maize mash and an experimental ration called barley mash. The diets and their costs are given in Table 1. The maize mash contained 40 per cent yellow maize meal, and the barley mash contained 40 per cent barley meal and no maize; both rations contained 2½ per cent grass meal for yolk colour and the barley mash contained rather less protein to give a similar energy: protein ratio in both diets.

Table 1

		Farm 1		Farm 2	
	Cost/ton 1968/69 £	Maize mash %	Barley mash %	Maize mash %	Barley mash %
Yellow maize meal	26	40	0	40	0
Barley meal	22	10	40	0	40
Wheat meal	24	20	32½	32½	35
Middlings	26	7½	7½	0	0
Grass meal	28	2½	2½	2½	2½
Protein/mineral/vitamin concentrate	64·25	17½	15	0	0
White fish meal	74	0	0	7½	7½
Soya bean meal	58	0	0	10	7½
Mineral/vitamin supplement	50	0	0	1¼	1¼
Limestone	6	2½	2½	6¼	6¼
		100	100	100	100
Inclusive cost/ton		£32·95	£30·55	£32·75	£30·30
Calculated met energy Cal/lb (Bolton)		1,265	1,180	1,285	1,180
Calculated crude protein %		16·1	15·5	16·6	15·7
Ratio ME:CP		78·6:1	76·3:1	77·4:1	75·2:1

Food costs applying at the time of the trial were used and £1·50 per ton included for milling and mixing.

Sykes H4 birds were used at Farm 1 and their average liveweight when housed at eighteen weeks old was 3·7 lb; hence they were termed a medium type hybrid. There were 1,344 birds on each ration. At Farm 2, the corresponding details were: Sterling White Link, 2·9 lb at sixteen weeks old; the birds were designated light hybrids and there were 1,200 on each ration. There were twelve replicates of each treatment at both farms to enable the results to be analyzed statistically. Food consumption, egg production and mortality were recorded from twenty weeks old onwards.

The trial lasted for forty-one weeks at Farm 1 and fifty-two weeks at Farm 2. On one day in each month all the eggs were graded and weighed; these results were applied to the total monthly egg production. The monthly results were totalled and the mean grading percentages and egg weights for the whole experimental period calculated. Egg receipts were obtained by applying average B.E.M.B. egg prices, without weighting, for the year July 1968–June 1969 to the total number of eggs in each of the grades. The results are given in Table 2.

Table 2

			Farm 1 (41 weeks in lay)		Farm 2 (52 weeks in lay)	
			Maize mash	Barley mash	Maize mash	Barley mash
Eggs/bird (hen-housed)		HH	170·10	168·99	240·20	240·60
,, (hen-day)		HD	189·02	186·13	256·64	260·37
Egg production %		HH	59·68	59·29	65·99	66·10
,, ,, %		HD	66·32	65·31	70·50	71·53
Mash eaten/bird lb		HD	70·20	73·81	108·48	110·09
Mash eaten/bird/day oz		HD	3·94	4·14	4·77	4·84
Food conversion, mash/dozen eggs lb			4·46	4·76	5·07	5·07
Increase in daily feed consumption %			—	5·1	—	1·5
Mortality %			19·3	19·1	14·2	14·6
Average egg weight		g	58·6	58·3	62·2	61·7
Egg grading	large	%	34·8	32·8	49·0	46·4
	standard	%	43·5	45·0	40·3	42·5
	medium	%	12·0	12·6	5·8	6·3
	small	%	2·3	2·4	0·3	0·3
	extra small and seconds	%	7·4	7·2	4·4	4·3
Margin* per bird	HH		£1·17	£1·17	£1·67	£1·77
,, ,, ,,	HD		£1·31	£1·29	£1·78	£1·91

*egg receipts less food costs

A fuller account of the trial, with a detailed examination of treatment variations, will be published elsewhere, but the trends are apparent without a statistical examination of the results.

Bird performance

The performance of both groups of birds at Farm 1 was depressed by the high mortality caused primarily by leucosis. Egg production was fractionally higher—by 1·0 per cent HD on the maize mash; this was largely caused by a small temporary fall in production during October 1968 of the birds on the barley mash when 'new' barley was introduced into the diet—this was done gradually over 3 weeks. Average egg weight and the number of large eggs was slightly higher for the birds on the maize mash, although the total percentage of eggs graded both large and standard was about the same on

both rations. Efficiency of feed conversion was excellent for both groups but the birds on the barley mash ate 5 per cent more food. However, because the maize mash was dearer by £2·40 per ton, the total food costs of the birds fed on this mash were slightly higher. The overall effect was that the margin of egg sales over food costs was about the same for both groups, the difference being 2p per bird HD in favour of the birds on the maize mash.

Egg production of both groups on Farm 2 was good, but that of the barley mash birds was fractionally higher—by 0·1 per cent HH or 1·0 per cent HD. Egg size and grading results were excellent for both groups, but again were rather better for the birds on the maize mash. However, as at Farm 1, the proportion of eggs graded both large and standard was similar on both diets. Although the birds on the barley mash ate about 1½ per cent more food, efficiency of feed conversion was the same for both groups. At Farm 2 the maize mash was dearer by £2·45 per ton, and the total food costs of the birds on this mash were slightly higher. The net effect was that the margin over food costs was greater for the birds on the barley mash by 10p per bird HH or 13p per bird HD. Food consumption at the farm was rather high, but this was probably due to the fact that during the winter temperatures were not always maintained within the house, which stood on an exposed site.

Present day costs

Before drawing a general conclusion an attempt has been made to relate the financial data to present-day costs. The results are given in Table 3. Food costs are those applying at March 1971, i.e., maize £35, barley £31, wheat £31, middlings £36, grass meal £35, protein/mineral/vitamin concentrate £82, white fish meal £106, soya bean meal £64, mineral/vitamin supplement £56, limestone £7, plus £2/ton for milling and mixing. For egg receipts, average B.E.M.B. prices for the year March 1970 to February 1971 have been applied—without weighting—as before.

Table 3

		Farm 1		Farm 2	
		Maize mash	Barley mash	Maize mash	Barley mash
		£	£	£	£
Inclusive cost/ton		43·40	40·53	42·44	40·01
Margin* per bird	HH	0·79	0·78	1·07	1·17
,, ,, ,,	HD	0·88	0·86	1·14	1·26

*egg receipts less food costs

It will be seen that although the margin per bird has fallen drastically—because of an extra £10 per ton on food costs—the difference in profitability between the birds on the two rations is similar to that obtained at 1968–69 prices. This was to be expected as the price differential between the cereals was about the same. The results at both farms indicate that with light-medium type hybrids very satisfactory results can be obtained commercially, using a mash containing 40 per cent barley meal and no maize, provided 2½ per cent grass meal is included to maintain yolk colour. Egg production should be similar but grading will be slightly poorer. The birds may eat rather more mash but as it will be cheaper the margin of egg sales over food costs should be at least the same. Clearly, the degree of replacement of maize by barley will depend on their relative prices; also to obtain the maximum benefit, the

protein content of the barley mash should be reduced slightly as about one-third of the reduction in food costs is attributable to this saving.

If the financial data for each ration are averaged for both farms for the year 1970/71, a 'break-even' price for the barley can be calculated to be £34 per ton when maize is £35, i.e., £1 per ton less. It is suggested, therefore, that the difference between these two cereals should be at least £2 per ton in favour of barley before there is substitution of maize by barley in any quantity.

Another factor that should be borne in mind is that the quality of barley is much more variable than maize, mainly because of weather conditions at harvesting; until more field experience is gained it is suggested that barley be restricted to about 40 per cent of the diet, the remainder of the cereal fraction consisting of wheat, and of maize if the price is right. Also, 'new' season's barley should be introduced into the diet gradually by mixing with old-crop barley for a time.

Acknowledgments

We would like to thank Mr. A. D. Turnbull, of Doxford, Chathill, Northumberland, Mr. H. Cooper and the Governors of the Cumberland and Westmorland College of Agriculture and Forestry, Newton Rigg, Penrith, Cumberland, for allowing us to conduct the trial and for their help and co-operation. We also acknowledge the assistance of Mrs. J. D. Bulman, Miss E. Duff, Miss D. A. Valks and the staff at the Veterinary Investigation Centres at Newcastle upon Tyne and Penrith.

This article has been contributed by one of the Ministry's Nutrition Chemists, **C. D. Rickaby, B.Sc.**, who is stationed at Newcastle upon Tyne, in conjunction with **G. Higginson, N.D.P.**, and **D. Pollicott, N.D.P.**, who are Poultry Husbandry Advisers stationed respectively at Beverley and Carlisle, and **J. B. Morrison, N.D.P.**, formally with A.D.A.S. at Newcastle.

Rinse out that container!

The smallest amount of toxic chemical left in a used container can be a real danger to children and animals. If it gets into a ditch or stream it can also poison fish and livestock.

Empty metal, plastic or glass containers should be thoroughly washed out and the washings added to the contents of the spray tank. Returnable containers should then be sent back to the suppliers without delay. Cardboard containers and plastic sheet bags should be emptied completely and these and other combustible containers should be burned. Non-returnable containers which will not burn should be punctured and flattened if appropriate and buried at least 18 inches deep in an isolated area: cleaned glass containers may also be disposed of with other refuse.

Partly-full containers should be tightly closed and stored in a safe place away from feeding stuffs and out of reach of children and animals.

Pesticides should never be transferred into other containers, especially beer and soft drink bottles.

49. North Riding of Yorkshire

Alec Calder

PROGRESS and tradition could well be the twin hallmarks of North Riding farming. Progress is continually evident as farming systems are mechanized and adapted to meet the economic challenge of the 'seventies. Tradition remains for all to see in clean crops, tidy farming and a delightful countryside. Free from industrial development, except in the Teesside conurbation, the North Riding is an almost entirely rural area. Here lie the broad acres and pleasant dales of an unspoilt agricultural community; absent are the smoky chimneys of industrial Yorkshire.

In many ways this Riding of Yorkshire provides a microcosm of English farming. It has nearly a million acres of agricultural land stretching from York in the south to the River Tees in the north. From the east coast at Scarborough to the Pennine watershed above Wensleydale and Swaledale is a journey of over 100 miles. Farming systems range from the intensive arable of the Vale of York to the hill sheep farm of the upper dales.

Vales of York and Pickering

The Vales of York and Pickering comprise much of the central and southern parts of the Riding. In this area of good quality soils and moderate rainfall, farming is based essentially on cash crops. Cereals, potatoes and sugar beet form the bulk of the cropping but most farms retain a grass break for cattle or sheep, thereby preserving a well-balanced farming system. So far, the more exotic vegetable and bulb crops have escaped the attention of the arable farmer. Although the soils are fertile enough to support any crop, the area is perhaps rather far north to catch the early market essential for traditional vegetable production; the advent of freezing and processing could well change this pattern in the future. Processing plants for potatoes have been developed recently at Scarborough and Catterick and increasing acreages of the crop are now grown for the processing market.

Cereal growers are expanding their enterprises into intensive livestock systems. Large scale indoor pig units are being developed as a means of marketing barley. Several large poultry enterprises are operating in both egg and broiler production in the Thirsk area and farther north around Stokesley.

Northwards from the Vale of York towards Yarm and eastwards towards Cleveland lies an area of heavy soils farmed essentially on a grass and cereals system. Traditionally, this was the home of the Bates shorthorn. Dairying is still an important enterprise in this area but other livestock systems have also developed; many farmers have adapted the 18-month beef system to suit their own conditions and beef is an increasingly important product of the area.

Western Dales

In the west of the Riding is the large area of Pennine upland divided by Wensleydale, Swaledale and Teesdale together with a host of smaller valleys. Each dale has its own peculiarities. The narrowness of Swaledale with its steep and abrupt valley sides presents farming problems entirely different from those encountered in the broad valley bottom of Wensleydale. Off-lying stone barns with a byre underneath are a feature of dales farming and sledge transport can still be found in parts too steep for the wheel.

In the upper dales, sheep farming predominates and the hardy Swaledale ewe is a common sight. Even in these remote areas the farming system is changing as more lambs are finished at home, reducing the high risk of the autumn store lamb sale. Marketing groups are springing up to provide a contractual supply of fat lamb direct to the wholesale butcher. Single suckler herds are gradually taking the place of the small milk producer and groups are developing to market the suckled calves.

Milk production is still important and, except in the extreme upper dale areas, forms the main livelihood of the farming community. Much of it is processed into Wensleydale cheese in small factories at Hawes and in Coverdale. The dales support a tourist industry, the potential of which is only slowly being realized and exploited. For most of the year, they present a picture of solitude and tranquility masking the activities of the traditionally first class stockmen.

North York Moors

To the east of the Vale of York above the formidable Sutton Bank and the famous Kilburn White Horse lie the North York Moors. This upland area, extending right across to the coast around Whitby, is of an entirely different character from the western dales. The dales here are narrow and small, dividing a vast area of unfenced heather moor. This inhospitable countryside supports declining sheep flocks but is, perhaps, a greater tourist attraction than the Pennine area. It is the playground of industrial Teesside.

Some of the lower land on the Moors has been reclaimed, but the agricultural value of much of the area is low. The dales are, however, well farmed and many small communities derive their livelihood from stock farming. The seed potato industry also thrives in this part of the county.

Land ownership

In common with most parts of the country the scale of enterprise in farming has increased over the years. There are 1,000 fewer farms of over 20 acres than there were ten years ago, largely as the result of farm amalgamations rather than losses to development. The large estate still dominates the pattern of land ownership in many parts of the Riding and it is with pride that a farmer will tell you that several generations of his family have farmed under a particular landlord.

North Riding is still predominantly rural and well conserved, exemplifying all that is best in English farming. In true Yorkshire fashion, its farmers will have nothing to do with gimmicks but prefer to put their trust in well tried traditional systems. There certainly has been progress and development but it has been tempered by a sound common sense that has been the basis of Yorkshire farming characteristics for generations.

Profit from Quiet Pigs

A. B. Trask, *A.D.A.S., Huntingdon*

THE reason for a successful farm building achieving good results can seldom be put down to a single cause and it often has less to do with the building than with the man who manages it. Here is the story of a fattening piggery for 800 pigs which Mr. David Collett built last year on his Rectory Farm at Luddington, on the Huntingdon/Northamptonshire border. It well illustrates the value of care in planning a livestock building as part of the production system of a farm business.

The piggery was born of a pressing need for new fattening accommodation for light pork and cutter production and its form was the product of Mr. Collett's conviction that as long as fattening pigs have a warm, dry bed they do best in as near natural conditions as can be achieved in their housing. In consequence, he decided against a controlled environment piggery in favour of a freely ventilated house with well insulated kennels and covered dunging passages. To be as labour-saving as possible the design would allow for mucking out by tractor-scraper and would incorporate a mechanized feeding system.

The structure of the building is a reinforced concrete portal frame 210 × 40 ft and 10 ft high to eaves, with roof and gables clad to eaves level with asbestos-cement sheeting. Two rows of kennels run the length of the building with an access passage between them and a dunging passage along either side. The kennels have 4 ft 6 in. high lightweight insulated concrete block walls and each measures 10 × 10 ft internally. They are individually roofed with timber framed lids covered with foamed polyurethane insulation board, double-hinged so that a small section nearest the access passage or the whole lid may be raised to view the pigs in the kennels. The floors of the kennels are of lightweight insulated concrete. Each kennel has a door to the central access passage and a pop-hole to the dunging passage. The 6 ft 9 in. wide dunging passages are divided into sections by sheeted steel gates, each carrying a water-bowl. The 5 ft high concrete block outer walls of the dunging passages run the full length of the building between the stanchions of the structural frame and the spaces between the walls and the eaves of the building are clad with pressure treated 4 × $\frac{3}{4}$ in. sawn boards spaced 1 in. apart which are the key to the diffused ventilation of the piggery.

The natural light which penetrates into the piggery through the spaced boarding supplements the lighting provided by seven 5 × 3 ft translucent panels spaced evenly in the roof sheeting.

The mechanized feeding system runs in two circuits, each covering half the piggery. It consists of a trough fixed just below the lids of the kennels in which a continuous chain with flights carries meal round the piggery and drops it about 3 ft through regularly spaced holes in the bottom of the trough on to the kennel floors. The amount of meal delivered to each kennel can be regulated by means of a graduated adjustment on the feeder. Each circuit is driven by a geared $\frac{1}{2}$ hp electric motor and feeding is controlled by time

clocks which automatically start feeding at pre-set times and cut off after 20 minutes. Feeding is at 7 a.m., noon, 4 p.m. and midnight and not less than two of these feeds are supervised daily by the pigman. Quantities of feed dropped into the kennels are adjusted so that the pigs clean the floor off in only a few minutes longer than feeder running time. If pigs in a particular pen do not clean up their feed the pigman brushes it out so as to minimize digestive disorders through ingestion of stale food.

At feeding time the visitor is struck by the quietness of the pigs in contrast to the pandemonium usually associated with feeding fattening pigs on restricted rations. Their contented grunting between feeds hardly rises when the automatic feeder starts and the pigs can be seen in orderly lines feeding off the floor. When the feeder stops they soon settle down to sleep in the kennels having moved little from their feeding positions. The virtual absence of squealing at feeding times can be attributed partly to the comparative frequency of feeding and partly to the fact that every pig in the building is fed at the same time. The feed conversion ratio is averaging 2·7 and the killing-out percentage has remained consistently high. The outstanding performance of this piggery indicates that it provides an environment for the pigs which subjects them to a very low level of stress, a result which has been achieved by meticulous attention to detail in design and management. The cost, before grant, of the piggery complete was about £18·50 per pig place, which is undoubtedly good value for money.

Taking the Guesswork out of Tractor Operation

A new British Standards Institution publication on controls of agricultural machines points out that 'a given direction of movement of any control on an agricultural or horticultural machine should produce a consistent and expected effect'. The fact that operators can be confused by lack of universal conventions in location, operation and marking of controls makes this field ripe for standardization.

The establishment of such a standard is brought a step nearer with BS 4746 *Recommendations for the location and direction of movement of controls of pedestrian operated tractors, agricultural and horticultural machines,** which deals with controls for tractors, rotary-cultivators, motor-hoes, motor-scythes and similar small pedestrian-operated machines.

BS 4746 takes eleven types of control, describes the function which they should perform and the movements necessary to achieve them, and recommends suitable locations. There are several additional recommendations, special emphasis being given to the importance of clear and permanent marking.

*Obtainable from the British Standards Institution, Sales Branch, 101 Pentonville Road, London, N1 9ND, price (to non-subscribers) 40p, including postage, remittance with order.

in brief

- **New mandate for the New Forest**
- **Glasshouse lettuce**
- **Research behind the dairy farmer**

New mandate for the New Forest

WHEN William the Conqueror sealed off 144 square miles of heath, marsh and woodland that stretched down to the Solent and Southampton Water and named it the New Forest, it was for the gratification of his own royal pleasure. Thus, we cannot ascribe any high motive to the first of the Norman Kings in this matter, though doubtless had the word 'conservation' then been coined it would have been so described! The fact remains, however, that this, one of the biggest areas of unenclosed land in the country, has ever since remained in the hands of the Crown to become a national heritage greatly prized equally by the Forest Commoners, naturalists, historians, foresters and the thousands of visitors who every year seek recreation in this uniquely picturesque part of Hampshire. Over the centuries its acreage of hardwood trees has supplied a considerable quota of timber as part of our national resources, supplemented more recently by softwoods—some 21 million cubic feet, for example, were supplied to meet the demands of the two world wars—and enclosures, now under the management of the Forestry Commission, have been made to safeguard future supplies. But modern industrial and economic requirements have shifted the emphasis onto the softwood trees, the conifers, away from the hardwoods, like the oak, beech and the ash, which have by general consent the greater amenity value.

The Minister of Agriculture, Fisheries and Food's new mandate to the Forestry Commission in its management of the New Forest will, however, help considerably to redress the balance between commercial timber production and the need to preserve and promote amenity. It reaffirms the national status of the Forest, in which priority must be given to the conservation of its traditional character. In pursuance of this, areas designated as ancient and ornamental woodlands should, as hitherto, be conserved without regard to timber production objectives, felling being kept to the minimum necessary to promote effective regeneration and limited to single trees or clumps of trees; furthermore, consideration should be given to the possibility that one or more areas might, on an experimental basis and in consultation with the Nature Conservancy, be totally enclosed and protected against all forms of human interference.

Within the timber enclosures the present balance between hardwoods and softwoods will at least be maintained, and no more hardwoods will be felled to make way for softwoods, except to a limited degree where soil conditions are unsuitable for the growth of hardwoods. Greater emphasis is placed on amenity in the management of hardwood areas, i.e., by a much longer rotation of at least 200 years, with felling limited to single trees or small groups in areas not exceeding about one acre.

Subject to certain conditions, further planting of softwoods will also be limited to those areas which have already been felled or have been prepared for this purpose or are currently planted with softwoods.

Glasshouse lettuce

WHETHER it is the cumulative effect of specialist food advice or the attraction of slim-line diets to offset the 'too, too solid flesh', salads now feature more prominently in our everyday menus than at any time hitherto. Here, of course, home-grown lettuce is the king-pin, and its availability for the greater part of the year, from supermarket, chain-store and corner shop alike, has automatically promoted it to a high place on the average shopper's list. Growers' participation in the British domestic market is therefore attractive, and in 1969–70 some 18,000 acres were devoted to this crop, of which 1,900 acres were under glass. The strategy of lettuce production under glass is thus all-important to the year's financial outcome and will differ between the specialist grower striving for the maximum and the non-specialist whose other crops in the rotation he holds to be of decisive importance.

The new English and Dutch varieties of lettuce, ranging through autumn, winter and spring, which have been added to growers' choice in recent years have markedly increased the potential scope of production by improved quality and compactness, quicker maturation and greater resistance to bolting, tipburn and leaf scorch. A new Ministry booklet *Glasshouse Lettuce** will most certainly be welcomed by growers, irrespective of their experience and whether they are using heated or unheated houses, since it embodies the latest advice derived from trials carried out at the A.D.A.S. Experimental Horticulture Stations and at the Glasshouse Crops Research Institute. It is concerned to equate costs and likely returns, details approximate sowing and cutting dates essential to continuity of market supply, and differentiates between growing conditions north of a line from the Humber to the Mersey and south of a line from the Thames to the Severn. Growers in the Midlands will naturally select intermediate dates.

Research behind the dairy farmer

THE ramifications of research into the economics of milk production in England and Wales are again well brought out by the Ministry's new publication, *Aspects of Dairy Economics, 1966–1969*,† the fourth of its kind in this series. Like its predecessors it pinpoints the results of university-based projects examining the many and diverse problems which affect dairy farming as a whole and individual producers over a wide range of regional conditions. As with the agricultural industry in general, dairy farming today finds itself within a completely new structure where the predominating factors are the relationship of input costs to product returns and improved management stemming from the stimulus of technological advance. Very little change has in fact occurred in the actual dairy cow population—the figure of 2,746,000 at June 1969 compared with 2,728,000 at the previous peak level in June 1962, though there has been a slight decline since the publication was written; it is in the fewer herds and their individually greater size, the emphasis on specialization, organization, methods of production and the comparative advantages of geographical location that we see new concepts to have been dictated by economic needs. Considerations of scale relative to profitability and the associated implications of capital investment are now the prime determining factors; and research, whatever the area of the industry is investigated, is the signpost to promoting viability.

Twenty-three studies are summarized and reviewed in this publication under the editorship of V. H. Beynon of the University of Exeter and R. E. Williams of the

*Single copies available, free, from the Ministry of Agriculture, Fisheries and Food, (Publications), Tolcarne Drive, Pinner, Middx., HA5 2DT.

†Obtainable from H.M. Stationery Office, price 50p (by post 54½p).

Milk Marketing Board, and another seventeen are cited as references, thus providing a survey which ranges from the general to the particular, including studies of the changes in the use of land, labour and capital and increased efficiency in feed resources. Not the least interesting is A. J. Wynne's study of milk transport, especially in its relation to the remoteness of main markets from the areas of heavy production. This is a complex question, the solution to which, *vis-à-vis* concentrated production, is likely to call for some radical thinking.

AGRIC.

Ministry Publications

Since the list published in the July 1971 issue of *Agriculture* (p. 315) the following publications have been issued.

MAJOR PUBLICATIONS

OUT OF SERIES

Cereals Deficiency Payments Scheme 1971 (New) 17½p (by post 20p) (SBN 11 241006 5)

MECHANIZATION LEAFLET

No. 13 Forage Harvesters (Revised) 9p (by post 11½p) (SBN 11 240670 X)

FREE ISSUES

ADVISORY LEAFLETS

No. 150 Millepedes and Centipedes (Revised)
No. 438 Clotted Cream (Revised)
No. 444 Magnesian Lime and Magnesian Limestone (Revised)
No. 528 Common Chickweed (Revised)
No. 574 Beekeeping—Making an Increase (New)
No. 575 Potato Aphids (New)

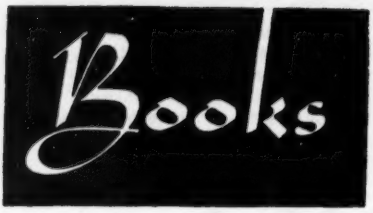
SHORT TERM LEAFLETS

No. 21 Hot-Water Treatment of Narcissus Bulbs (Revised)
No. 24 Preservation of Grain Quality during Drying and Storage (Revised)

PERFORMANCE TRIAL REPORTS

No. 49 Spring Wheat 'Toro' (New)
No. 50 Potato Varieties (New)

Priced publications are obtainable from Government Bookshops (Addresses on p. 372) or through any bookseller. Single copies of the free items are obtainable from the Ministry of Agriculture, Fisheries and Food (Publications), Tolcarne Drive, Pinner, Middlesex HA5 2DT.



Farm Livestock. GRAHAM BOATFIELD. Cassell Farm Books, Cassell. 35p.

The third, revised edition of Graham Boatfield's *Farm Livestock* attests to the popularity of this little book. With its economy of language and wealth of relevant and important facts upon which to base a study of pigs, cattle and sheep it bears the stamp of a very good set of student notes. Agriculture in the modern world is subject to considerable pressures and changes, but basic facts and principles remain unaltered. The farmer and farm worker still need a discerning eye: stock still look for their food. The author recognizes and meets such needs with easily understood practical instruction and advice backed by a sound scientific approach. The husbandry that men have developed over thousands of years is allied to the industrial and scientific developments and to the technical progress and more sophisticated equipment of modern times.

The original approach of this book has several advantages. It makes direct points in simple language. It is systematic and has good diagrams and tables. The text is clear and unencumbered with technical terms. It contains numerous sound suggestions for further observations and investigations. It can be used by students on their own and is an excellent introduction to more advanced study.

The foreword states: '*Farm Livestock* requires positive work from the student, based on farm observation and simple investigation carried out locally; at the end of each section is a list of things to do, places to visit and facts to discover'.

For schools and agricultural colleges, indeed, for anyone embarking upon a farming career, it is a thoroughly useful book.

J.A.S.

All About Pigs. Farming Press, 1970. £1.

This is the third and entirely new edition of the book and consists of over 700 replies to enquiries gathered from letters written to the Editor of *Pig Farming*. These enquiries and their replies have been grouped under the headings of breeding, feeding, housing, management and veterinary. The book is basically a compendium of short, sharp answers to many likely questions on pig keeping.

The book covers a very wide field and it is surprisingly easy to find likely information in spite of the absence of an index. Most of the questions are dealt with well but some require much fuller answers than one could expect to receive from such a source. Provided the reader realizes this, the answers should whet his appetite to look further.

Some subjects are given more space than others and the chapter on breeding, for instance, could be criticized as being too brief. On the other hand, that on housing is packed full of useful information supported by clear illustrations with adequate measurements shown.

The book comes in paper-back form and at £1 is good value for money.

H.F.

The Veterinary Annual 1970. Edited by C. S. G. GRUNSELL. John Wright and Sons, 1971. £3·25.

Professor Grunsell's preface to this eleventh issue of *The Veterinary Annual* emphasizes the importance of specialization and the need to be aware of developing fields. The Current Developments section is now dealt with on a species basis and in the bovine field there are articles on brucellosis and mastitis. The former outlines the progress of the brucellosis schemes and illustrates the importance of statistics in modifying procedures as these schemes develop. The mastitis article is reprinted from *Biennial Reviews of the National Institute for Research in Dairying* (1970) and it is unfortunate that a previously published paper has been included.

The Review of Current Literature is continued and the information built up over the years is considerable. The Registrar of the Royal College of Veterinary Surgeons discusses recent legal decisions and

new legislation. In the section on animal husbandry Professor T. K. Ewer contributes a review of the Swann Committee findings and R. Ewbank deals with the increasingly important subject of farm animal behaviour. He points out there is still a considerable lack of knowledge of naturally occurring field conditions, which appears to be the primary bar to veterinarians understanding and dealing with abnormal behaviour in farm animals. He suggests that field workers must be persuaded to record and publish accounts of abnormal behaviour and an attempt must be made to 'monitor', not 'inspect', some of the intensive and non-intensive systems.

The Veterinary Annual continues to be a gold-mine for the field worker who wishes to obtain essential information about current progress. It has been referred to as the lazy man's way of keeping in touch (Heath, 1971).* One could disagree with this, but not with Heath's comment that 'Most of the articles are much less tedious than is usual with review articles'.

R.D.L.

*B.G.S. Heath (1971). *Vet. Rec.*, **88**, 377.

Agricultural Chemicals Approval Scheme

There are no Additions or Amendments to the 1971 List of Approved Products for Farmers and Growers this month.

ACKNOWLEDGMENT OF PHOTOGRAPHS

We gratefully acknowledge permission to use the following photographs:

Pp. 345, 346 and 347, J. Perry.

AGRICULTURE

Price 7½p net monthly

Postal subscription rate, Home and Overseas: £1·20 per annum

Subscriptions may start with any issue and should be sent to:

HER MAJESTY'S STATIONERY OFFICE

49 High Holborn, London WC1V 6HB
13a Castle Street, Edinburgh EH2 3AR
Brazennose Street, Manchester M60 8AS
258 Broad Street, Birmingham B1 2HE
109 St Mary Street, Cardiff CF1 1JW
50 Fairfax Street, Bristol BS1 3DE
80 Chichester Street, Belfast BT1 4JY

Single copies can be purchased from any of the above-mentioned addresses or through booksellers.

Printed in England for Her Majesty's Stationery Office
by Hull Printers Limited, Willerby, Hull, HU10 6DH.

Dd 500884 (K72) SBN 11 722438 3

a service in government publications

Her Majesty's Stationery Office offers its readers a comprehensive service that will enable them to judge which titles in the vast output of Government Publications would help them in their work or leisure.

Catalogues are published daily, monthly or annually; in the latter two cases, Statutory Instruments are omitted, and separate catalogues for these are published. In addition, numerous sectional catalogues, issued free of charge, list the publications sponsored by individual Government Departments, and in some cases lists covering special subjects are available.

HMSO

You can obtain full information about this service by sending a postcard to Her Majesty's Stationery Office, P6A, Atlantic House, Holborn Viaduct, London, EC1P, 1BN asking for our CATALOGUE SERVICE LEAFLET.

Ask at the same time for the name and address of your nearest official agent for Government Publications.

MINISTRY OF
AGRICULTURE, FISHERIES AND FOOD

Plant Pathology

A quarterly publication presenting original contributions on plant diseases, plant pests, rodent and bird damage, nutritional and physiological disorders of interest to the mycologist, entomologist, helminthologist, soil or nutrition chemist, plant physiologist and meteorologist.

Single copies 42½p (47p)

Yearly subscription £1·88 (including postage)

Published by

HER MAJESTY'S STATIONERY OFFICE

and obtainable from the Government Bookshops in London (post orders to PO Box 569, SE1 9NH), Edinburgh, Cardiff, Belfast, Manchester, Birmingham and Bristol, or through booksellers